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Boundaries.
A Study in the Metaphysics of Space.

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«There should not be more things dreamt of in my philosophy than there are in heaven or earth.»

Nelson Goodman, *Fact, Fiction, and Forecast.*

«Feet on the ground, head in the sky
It's okay, I know nothing's wrong, nothing

I got plenty of time
You got light in your eyes
And you're standing here beside me
I love the passing of time
Never for money, always for love
Cover up and say goodnight, say goodnight

Home, is where I want to be
But I guess I'm already there
I come home, she lifted up her wings
I guess that this must be the place»

Talking Heads, *This Must Be the Place.*

«Indeed, the only truly serious questions are ones that even a child can formulate. Only the most naive of questions are truly serious. They are the questions with no answers. A question with no answer is a barrier that cannot be breached. In other words, it is questions with no answers that set the limit of human possibilities, describe the boundaries of human existence.»

Milan Kundera, *The Unbearable Lightness of Being.*

Contents.

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0. Introduction.

> «Daughter: Daddy, why do things have outlines?
> Father: Do they? I don't know. What sort of things do you mean?
> D: I mean when I draw things, why do they have outlines?
> F: Well, what about other sorts of things, a flock of sheep? or a conversation? Do they have outlines?
> D: Don't be silly. I can't draw a conversation. I mean things.
> F: Yes—I was trying to find out just what you meant. Do you mean "Why do we give things outlines when we draw them?" or do you mean that the things have outlines whether we draw them or not?»
>
> Gregory Bateson, *Steps to an Ecology of Mind*

You're starting to read my dissertation. Arguably, you are doing it, sitting in a chair in front of a desk. I give you a very easy task: touch the desk with your hand. Done? Well, the rest of my dissertation will be the proof that you cannot do it, since two distinct things, such as your hand and the desk, can never be in touch, whatever the structure of space is.

Since there are no ways for account for the intuition according to which two things can touch each other, my suspicion is that boundaries do not exist. Indeed, boundaries should ensure such a task. But if they do not, it is perhaps because they do not exist.

In this dissertation, I defend the claim that there are no natural boundaries but rather every boundary is a product of conceptual schemes, practices and, more generally, of human beings' activities.

I develop in detail some arguments against boundaries. But since boundaries seem to be necessary in order to talk about things, I then

outline a theory of *fiat* boundaries, i.e. boundaries that depend upon human beings for their existence. I set up a taxonomy of the various kinds of *fiat* boundaries and the way in which they are created and the relationships they maintain with the thing they bound. I conclude that things exist in virtue of their boundaries: since things are individual, by definition, and boundaries make the difference between things and their surroundings, then things would exist in virtue of their boundaries. And since boundaries depend upon human beings, the conclusion is straightforward. The resulting picture is a world without natural joints. Nevertheless, the world itself does not depend upon human beings. Only its structure is a projection of our way of representing it.

I try to give evidence that that theory of *fiat* boundaries can be useful to take up as a starting point for doing metaphysics and for giving an account of the ontology of the material world.

Furthermore, I argue that a theory of *fiat* boundaries can explain the concept of landscape, its cultural significance and origin. I show that that theory can be adopted by both geographers and urban designers in order to better understand the relation between landscape, as *fiat* entity, and territory, as *bona fide* entity. Making up landscape is a putative case of the work of *fiat* boundaries.

I develop such issues with the help of formal methods, introducing them step by step. My methodology of formal analysis is as follows. I pick up statements about boundaries from both commonsense and scientific discourse. I am interested in both ontological statements such as «boundaries exist» and metaphysical statements such as «boundaries are such and such»[1]. I then turn the best version of these statements into formal sentences, in order to clarify their structures and deduce any

[1] Ontology is the study of what there is and metaphysics the study of what is what there is. See § 4 for deeper notions of metaphysics and ontology.

corollaries within a formal framework, e.g. mereology. The further step is to test their consistency and validity. The final aim is to obtain the most parsimonious ontology along with the most parsimonious ideology, i.e. the set of predicates of a theory. The first aim is easily reached by denying the *bona fide* existence of boundaries, whereas the second has to be reached with a theory that lessens the number of primitives of the theory.

Let me very briefly introduce the issues of the dissertation and the core assumptions I adopt.

0.1 Keep in Touch.

Intuitively, two things touch each other just in case their boundaries touch. I will argue that either such a condition cannot be met, or it leads to an inconsistent conclusion, for instance, it entails colocation, contradictions, necessarily empty space, non-dimensional entities, and so forth. Thus, contact among things is impossible or, at least, inconsistent with other logical, metaphysical and physical posits.

I will argue that if contact is impossible, then boundaries do not really exist and, thus, the fact that there are discrete things is a fiction.

Let me briefly introduce the issue. Later I shall return to each of the topics sketched here.

What are boundaries? Roughly, boundaries are the outermost parts of things, as Euclid (*Elements* Bk I, Df 13) and Aristotle (*Metaphysics* V, 17, 1022a 4–5) point out. Furthermore, boundaries divide things from their environment and allow them to touch each other. As we will see this definition is not enough, but assume it for the sake of simplicity.

Instances of boundaries are straightforward:

1. The point vertex of a cone.
2. The borders of Italy.
3. The coastline of Sardinia.
4. The skin of my body.
5. The end of the football match.
6. The beginning of my life.
7. The surface of a desk.
8. The horizon.
9. The division between sexes.
10. The limit between sea and sky.

Some of them are zero dimensional, as in 1, 5, and 6, some other are one dimensional, as in 2, 3, 8, and 10, some other are two dimensional, as in 4 and 7. They may be spatial, as in 1, 2, 3, 4, 7, and 10, or temporal, as in 5 and 6, or neither of the two, as in 9. They are ontological dependent upon human beings, as 2, 5, and 8, or ontological independent, as in 1, 3, 4, 7, or having an indeterminate status, as 6, or being a mixture, as in 9.

Despite of the various kinds of boundaries mentioned, the dissertation will be devoted just to spatial ones. I think all the considerations stated here are applicable to every kind of boundaries, such as temporal or abstract. Such issues are beyond the aims of the dissertation. Henceforth, I use the term «boundary» as an ellipsis of «spatial boundary».

Instead of the rough definition I stated, consider now the mainstream boundary definition. According to the mainstream theory, every of the spatial instances above are characterized as (1) either parts of the thing they bound or parts of the complement of the thing; (2) having fewer

dimensions than the bounded thing[2] (Brentano 1933; Chisholm 1984, 1992/93; Varzi 1997; Smith 1997; Casati and Varzi 1999; Smith and Varzi 2001).

According to (1) a thing can be either closed, i.e. it includes boundaries among its parts, or open, i.e. it does not include boundaries among its parts.

In the first case, there is a part, or parts, of the thing whose aim is to bound the interior of the thing, e.g. the surface of the desk or the skin of your hand.

In the second case, the outermost part of the complement of the considered thing, serves as boundary of the open one, e.g. the boundary of a black spot in a white ground serves as boundary of both the spot and the ground.

According to (2) if a thing has *n* dimensions, its boundaries have fewer dimension dimensions than it. For instance, the boundary of the three-dimensional desk, is its two-dimensional surface.

Both such features of boundaries are highly problematic.

Let's begin with the intuitive idea according to which boundaries are parts of a whole. Consider 10: which one between sea and sky is the owner of the boundary[3]? If the answer is "both", then we are committed to the surface(s) of the sky. It seems suspicious. If the answer is just one of them, we have to establish which one and so we find ourselves in a tough position: it is metaphysically arbitrary, either way.

Now the dimension of boundaries. Consider 1: how is it possible for a thing to have a zero dimensional part? Imagine that the cone loses the point at the vertex. We could think that the point behind takes place of

[2] Boundaries along with sounds, holes, shadows, and hiccups belong to the lesser kinds, i.e. kinds of spatial things yet with controversial spatial status, that is without exact location, without dimensions, without mass, and so forth (Casati and Varzi 2007).
[3] The question is a famous problem stated by Leonardo da Vinci (1938), see also § 2.1.

the first, doing the job of boundary. Imagine that the cone loses also that point, then the one behind and so on. Since every point is zero dimensional, when a thing loses one, its constitution and its mass do not change. At the very least: one thing can lose each of its points and yet it does not change. It seems at least odd.

All these conundrums and problems are due to the highly controversial nature of boundaries.

What if boundaries do not exist?

0.2 Living in a *Fiat* World.

There are many arguments against the existence of boundaries: vagueness, lower dimensionality, arbitrariness, and so forth. I develop each of them in detail, trying to show that they are more compelling than the reasons to believe that they exist. . I will pursue this aim by showing the inconsistency of boundaries with other metaphysical theses and intuitions.

If there are no boundaries at all the paradox of contact may not arise. But the price of such a theory seems too high: a world without boundaries is a world without things, for at least in so far, we know things need boundaries in order to be what they are. Otherwise, there would be no difference between a single thing and its surrounding. Suppose you have to individuate the identity or sortalish properties of a thing. Assume for the sake of simplicity, that such conditions are: location in space, persistence across time, and composition.

Suppose a thing without boundaries: you cannot identify where it begins and where it ends; you cannot say how and how long it persists, since it does not have neither a start, nor an end; you cannot say how

many parts it has, since there is no discontinuity among its belonging parts and the remainder of the world.

Consider a thing that owns boundaries: you can say where it is, i.e. where there are its boundaries; you can say how and how long it persists, knowing when it comes into being and when it goes out; you can say how many parts it has, counting every thing within its boundaries, and so forth.

Therefore, a world without boundaries is a world without things, as I better argue in chapters 2 and 5. Is it too high a price?

I argue there is a way to accept the problems due to boundaries and nevertheless preserve things in our ontology.

I maintain precisely such thesis, which I call "Spatial fictionalism", that is the theory according to which every boundary is, at the very end of the day, of the *fiat* sort. This thesis is a development of the thesis of *fiat* boundaries defended by Smith (2001), Smith and Varzi (2001) and Varzi (2011, 2013, 2014).

Fiat boundaries are fictional articulations of reality. They do not belong to the furniture of the world; rather they are projections of human beings into the world. National borders, galaxies, and the horizon are products of our conventions, our language, our perceptions, and our scientific schemes.

Fiat boundaries can demarcate portions of reality, giving such portions individuality. Namely, they pick up qualified portions of reality in order to distinguish such portions from their surroundings. Indeed, boundaries can be defined as the last parts of a thing, in other words, what distinguishes a thing from its environment.

If boundaries exist only as a result of *fiat* acts, the things they bound also inherit this ontological status. Therefore, a world in which every boundary is *fiat*, is a world populated by only *fiat* things.

What I finally depict is, borrowing the words of Dummett (1981), a «world as an amorphous lump» and the division of it in discrete things, i.e. things without parts in common, is due to our cognitive, conceptual and conventional practices. Such practices, using again a metaphor, are as cookie-cutters employed by us in order to carve the lump into discrete things (Putnam 1980)[4].

A world like this is not a world without laws or without differences: there are ways of dividing it that are better than others, and there are many ways of doing it. I set up a taxonomy of different kinds of boundaries, their different relevance and eventually they way in which they are carved out.

To sum up, Spatial Fictionalism is the conjunction of three claims:

(a) *Dependence on Boundaries*: Things derive their individuality from their boundaries: speaking of things without boundary is meaningless.

(b) *Fiat Boundaries*: Every boundary is of the *fiat* sort.

(c) *Stuffism*: Stuff is of the *bona fide* sort.

0.3 Things and their regions.

So far I have employed the term "thing" without specification; some clarification is needed. By that term I mean entities that occupy other entities: material objects, lumps of stuff, events.

[4] Note that Putnam uses this metaphor just to reject the theory it represents.

From a naïve point of view it seems that the world - the spatio-temporal domain of quantification - is full of things. Quoting David Lewis (1990: 23) «few entities – present, actual, particular, spatiotemporal, material, well-bounded things – exist uncontroversially. Scarcely any philosopher denies them». A large number of examples can be taken from the history of philosophy in order to confirm what Lewis asserted[5]

Also our ordinary experience of the world is deeply committed to the existence of at least some of such things – middle-sized, topologically connected, discrete, composite, singularly-located things. Instances of such things are cats, human beings, trees, tables and so forth. Scarcely any human being denies them.

Every of such thing is the occupant of the region of space it actually occupies; scarcely any human being denies this either. By the term "region" I mean an entity that can be occupied by another entity

Things and regions are metaphysically irreducible to each other, i.e. they are neither identical with each other, nor related by a reduction relation, such as grounding relation, ontological dependence or supervenience relation.

Such a doctrine is usually called substantivalism. I assume it for the sake of simplicity. Nevertheless supersubstativalism, i.e. the doctrine according to which things are identical to the region they occupy, and relationism, i.e. the doctrine that holds that only things exist whereas regions are abstraction, would have been employed with success for pursuing the same aims.

Spatial fictionalism claims exactly that every thing that seem to be in our world is of the *fiat* sort, since it depends on *fiat* boundaries.

[5] Addressing this historical issue is beyond the aim of the dissertation, see Dasgupta 2014 for a list.

Henceforth, I employ the term «things» to refer to the entities here described and the term «entities» with a more general extension that includes every possible referent of every possible word.

0.4 Boundaries from an Ontological and Metaphysical Point of View.

The dissertation you're reading is devoted to ontology and metaphysics. The problem of boundaries is central to both. Let me very briefly explain why.

Ontology and metaphysics are deeply related but nonetheless they are different. The first is devoted to listing what there is, whereas the second seeks to explain what is what there is.

0.4.1 Ontology.

According to a venerable tradition[6], the task of ontology is to draw up a catalogue that has to include every thing that there is. If something exists, then it must have a place in the catalogue. That characterization of ontology is currently known as the standard account[7].

The standard way to fulfill the task is through the study of the ontological commitment of a theory. That is, finding out what entities a theory quantifies over. The entities there exist are the entities we discover in the domain of the quantifier.

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[6] The first who gave this definition of ontology was Quine 1948: 21-38.

[7] For a very nice introduction of this topic see, *inter alia*, Berto & Plebani 2015: 15-55. I develop the paragraph following Bricker 2016. There are at least other two different characterizations of ontology: the Artistotelian and the Carnapian. According to the Aristotelian view the task of ontology is to find out what is more fundamental. According to the Carnapian view, ontology asks mere pseudo-questions. Quantification is to be referred just to a framework and thus every world-talk makes sense only within a context. For the Aristotelian view see Fine 2009: 157-177. For the Carnapian view see Chalmers 2009: 77-129.

In its metalinguistic formulation[8]:

«A theory T is "ontologically committed" to Ks iff T logically entails "∃x Kx" iff, for every interpretation that makes T true, there is some entity in the domain of the interpretation that is in the extension of 'K'» (Bricker 2016: 14)[9].

As Peter van Inwagen (1998) suggests, in order to find such entities in the domain of a theory, the theory must be written in a language with quantifiers[10]. Here is a short list of examples:

There are landscapes.
∃xLx

There are exactly two landscapes.
∃x∃y (Lx ∧ Ly ∧ x≠y ∧ ∀z (z=x ∨ z=y)

Everything is a landscape.
∀xLx

Every territory is a landscape.
∀x(Tx⟶Lx)

[8] A metalanguage is a language used for speaking about another language, called object-language. In that case, the metalanguage is the natural language and the object language is the one of first order logic.
[9] The universal quantifier ∀ entails an ontological commitment too. For the sake of simplicity, I expose here just the case of existential quantifier, but I make examples also with the universal ones.
[10] I assume it for the sake of simplicity. But, it is usually argued that in order to find the ontological commitment a complex procedure of paraphrasing is needed. See van Inwagen (1998).

It seems easy, but it is not so. Consider the example of landscape. We use such a label in our scientific and ordinary talk and, hence, we assume it in the extension of such talk. Therefore, landscape exists. Are we sure that landscape is in the domain of quantification?

On the one hand, landscape seems to be in that domain, since its existence is entailed by the truth of some of our best scientific theories, e.g. urban planning, geography. On the other hand, it seems that it is just a *façon de parler*. We use the term «landscape», but we are just labeling with that name another thing, namely the territory. Thus, there are no two different things, rather there is just one thing labelled with two different names.

Problems like that are the ones which ontology has to face.

Why are boundaries crucial in that business? Since boundaries pick out entities from their environment and ontology is basically a matter of counting, boundaries permit us to count every entity as one. Otherwise, without boundaries it would be impossible to distinguish one entity from another. Doing ontology without accepting boundaries, at least when the domain of quantification is the space, would entail that there exists just one entity in that domain. Moreover, boundaries permit us to distinguish between entities that own their boundaries naturally and entities that rather have only *fiat* boundaries, namely, entities that are picked out by means of our representations.

0.4.2 Metaphysics.

There is no sharp distinction between ontology and metaphysics and the epistemological status of metaphysics is highly debated. According to Carroll and Markosian (2010: 4), there are at least three approaches to metaphysics: the etymological approach, the big-picture approach and

the definition-by-examples approach. The etymological approach defines metaphysics following the literal meaning: the discipline after the physics. It is worth noting that the name was coined by the first editor of the Aristotle's writings. The big-picture approach defines metaphysics as the study of the most fundamental nature of reality. The definition-by-examples approach does not directly define metaphysics, rather it lists the main topics of the disciplines. It resembles the definition of philosophy recently given by Marconi (2014), as the discipline that studies philosophical problems.

I defend a third view between the big-picture approach and the definition-by-examples approach.

I think the right characterization of metaphysics is as the study of the most fundamental structure of reality[11]. Using a famous slogan, the mission of metaphysics is «to carve nature at its joints»[12]. The central task of metaphysics is then to distinguish what is merely a representation of reality and what really belongs to it. In other terms: what in our ontology is a feature of a representation, non-fundamental reality, and what is part of the furniture of the world, fundamental reality. Using a widely known definition by Varzi (2011c), the aim of metaphysics is to explain what the members of an ontological list are, i.e. to specify the ultimate nature of those things.

Here is a short list of some of the representative questions of metaphysics:

1. Persistence: Do ordinary objects persist through time being wholly present at every instant of their careers or are they composed of temporal parts?

[11] As claimed, *inter alia*, by Lewis 1983: ix, Lowe 1998, 2011, and Varzi 2011a.
[12] That slogan has its roots in Plato's metaphor of a butcher in his *Phedro* 265d-266a.

2. Identity: Is identity absolute, regardless of time, region of space, sortal, etc.[13]?

3. Essentialism: Are there essential properties[14]?

4. Composition$_a$: What are the conditions for an object's being composite[15]?

5. Composition$_b$: Is the whole distinct from the sum of its parts[16]?

6. Form versus matter: Are there formal parts beyond material parts?

7. Location relation: How many locations in space may an object have at a certain given time?

However, the task of metaphysics cannot be reduced to the study of the structure of actual reality. Metaphysicians are involved in a more demanding business: discovering what is necessary, i.e. what must hold whatever the structure of reality is. Each of the questions above is crucial for metaphysicians not just as a question about our world, but as a question regarding every possible world. In other terms: are their answers necessary?

Metaphysical necessity is different from commonsensical, logical and scientific necessity. These kinds of necessity are valid only within a

[13] Can identity be vague?
[14] How are essential properties discernible from accidental ones?
[15] Is an object something over and above its parts?
[16] Related to it: Is it possible for an object to share its location in space with an entity of a different sort? Is it possible for two distinct object to be made of the same parts?

specific framework, e.g. that of a theory or that of a situation. For instance:

«Necessarily, water boils at 100 ºC»

Such an assertion is surely true according to the laws of the physical nature of our world. However, we can imagine a perfectly consistent situation with different laws of nature, where water boils at 99 ºC.

Consider the following assertion:

«Necessarily, I'm a human being»

It seems that in every possible situation in which there is something similar to me, that something has to be a human being, regardless of laws of nature, theories or contexts of utterance[17].

Such situations are usually called «possible worlds». And it is usually said that «possible» has to be understood as «at least in one possible world», whereas «necessarily» has to be understood as «in every possible world»[18].

Necessity and possibility have an important feature: they can refer either to statements or to things. In the first case we are in the presence of a *de dicto* modality, i.e. modality that refers to *dictum*; in the second case, a *de re* modality, i.e. a modality that refers to *res*.

Only the second is crucial for the business of metaphysics.

[17] Such a statement is highly controversial, but let us assume it for the sake of argument.
[18] One of the main advantages of this approach is to uncover the mystery of intentional contexts of modality. Indeed, the possible world-semantics for the modal operators can turn the opaque context into an extensional one. "Necessarily" turns into a universal quantification over possible worlds. "Possibly" turns into an existential quantification over possible worlds.

Consider the statement according to which it is necessary that every bachelor is unmarried. There are two ways of stating it:

De dicto: «Necessarily, every bachelor is unmarried»

De re: «Every bachelor is necessarily unmarried»

Under a *de dicto* reading, the statement says that in every possible world in which a man is unmarried, he is a bachelor. The statement is obviously true.

Under a *de re* reading, the statement says that every bachelor that he is unmarried is so in every possible world. That is, he is unmarried as a matter of necessity. It is obviously false, since it seems possible that someone who is unmarried in our world may have been married in another world.

One of the main tasks for metaphysicians is to find out the difference between what is *de re* such and such and what is merely *de dicto* such and such, namely what is necessary for a representation of reality and what is necessary for the reality itself.

Against this background, we can then state what is the role of the boundaries within metaphysics. What I argue in the dissertation is that every boundary is of the *fiat* sort and that position can be compared with the famous thesis by Quine according to which every modality is of the *de dicto* sort. In arguing that I will show three reasons for the relevance of boundaries within metaphysics, namely: 1. Boundaries are interesting in themselves, since it is a deeply metaphysical puzzle whether or not boundaries are parts of the fundamental furniture of reality; 2. Boundaries can be understood as the joints of reality: studying boundaries is studying the fundamental structure of reality; 3. Setting up

a model that is able to distinguish *fiat* and *bona fide* boundaries, can be useful to discern representations and reality.

0.5 Boundaries of Landscape.

Boundaries are not only pervasive in ontology and metaphysics. Other disciplines also have a deep interest in them.

For illustrating such relevance, I will show a specific case within a specific discipline, namely theory of urban planning. In particular I show that boundaries are fundamental in order to define landscape. Since landscape is a crucial notion for urban planning, boundaries also play a fundamental role in that discipline.

An ontological and metaphysical study of boundaries may help to make clear the role of boundaries within urban design. In particular, the approach of *fiat* boundaries may help in defining the complex notion of landscape.

According to most of the literature[19], landscape is defined as a slice of territory delimited by boundaries[20], whose nature may be either *bona fide* or *fiat*: a landscape may be delimited by a natural boundary, e.g. the coastline, or by a conventional boundary, e.g. the horizon. Often, a landscape has both kinds of boundaries.

Within spatial fictionalism, the difference is not between *bona fide* and *fiat* boundaries anymore. Rather, the difference is among various kinds of *fiat* boundaries. The theory can be helpful in (i) understanding the nature of boundaries of a landscape, e.g. social, linguistic, and so forth; (ii) capturing the intentions of those who chose the boundaries. Indeed,

[19] See Bonesio 2007 for a survey.
[20] The definition is equivalent to the one of European Convention of Landscape, art. 1.

if every boundary is fiat, every one depends on a *fiat* act: a decision. Spatial fictionalism investigates such decision.

Furthermore, I show some other use of the theory of *fiat* boundaries within the theory of urban planning.

0.6 Layout of the Dissertation.

The dissertation will be divided in three parts. In the first I present the issue of boundaries and I defend some solutions to main problems pertaining to them. In the second part I argue against *bona fide* boundaries and I set forth the theory of *fiat* boundaries. In the third part I argue that the theory of fiat boundaries may be helpful in solving some problems in theory of urban planning.

Let me very briefly introduce you to each every part of the dissertation.

Part 1. The nature of Boundaries.

Part one will be devoted to an overview to the nature of boundaries.

Since this dissertation is about spatial boundaries, I need to make some basic assumptions about spatial things. I do it illustrating three theories: mereology, i.e. the theory of parthood; mereotopology, i.e. theory of connection; and theory of location, i.e. the study of the relation between things and places (Ch. 1).

Thereafter, I deal with standard and nonstandard characterizations of boundaries, stressing the distinction between *bona fide* boundaries and *fiat* boundaries. Moreover, I claim that a correct characterization of boundaries can be helpful in solving (i) the mereological problem of composition: some things compose something iff they lie within its

boundaries; (ii) the problem of location: a thing is located exactly where its boundaries are located (Ch. 2).

Once you have such a characterization of boundaries, you can finally appreciate the so called «contact paradox»: how two discrete things can touch each other. That chapter will show that contact is either impossible, or highly counterintuitive (Ch. 3).

Part 2. Living in a Fiat World.

I then will argue both directly and indirectly against bona fide boundaries. I set forth several arguments against their existence as *bona fide* entities. (Ch. 4).

The final picture turns out to be that of a world lacking natural joints. Nevertheless, I claim that some boundaries there exist, i.e. boundaries that depend upon human beings. I set forth a classification of the various kinds of *fiat* boundaries, a comprehensive model that has to explain how such boundaries are brought into existence by means of *fiat* acts. In the last part of the chapter I outline a general metaphysical overview of a world with only fiat boundaries. I call it spatial fictionalism. My aim is to show that it can be a very useful model in order to join metaphysical antirealism and ontological realism (Ch. 5).

Part 3. Applications.

In the last chapter, I will show how such a conclusion can be a useful device for philosophy of urban planning and for urban planning itself. Indeed, I will try to apply such a theory to the analysis of landscape in order to solve some conundrums about planning and boundaries: owning of a territory, extension of a plan, protection of heritage (Ch. 6).

PART 1.

THE NATURE OF BOUNDARIES.

1. Formal Theories of Space.

> Marco Polo describes a bridge, stone by stone.
> "But which is the stone that supports the bridge?" Kublai Khan asks.
> "The bridge is not supported by one stone or another," Marco answers, "but by the line of the arch that they form."
> Kublai Khan remains silent, reflecting. Then he adds: "Why do you speak to me of the stones? It is only the arch that matters to me."
> Polo answers: "Without stones there is no arch."
>
> Italo Calvino, *Invisible Cities*

In this chapter I present three formal theories, crucial for understanding boundaries.

A formal theory is a collection of symbols and precise rules for manipulating them in order to reach combinations, called theorems. The meaning of the basic operators of the language is fixed by means of axioms. The meaning of the sentences of the theory is given by a model that represents a world.

The formal theories I introduce are usually considered as parts of formal ontology[21]. Formal ontology is a branch of analytic metaphysics that aims to use formal methods in order to solve or to clarify some classical ontological problems, such as composition, i.e. how things

[21] I set up here a particular meaning of formal ontology. There is also another meaning, namely the one stated by Husserl (2001) in his *Logical Investigations*. According to him, formal ontology is committed to study the more general features of reality.

compose a whole; dependence, i.e. how things are related by dependence relations; persistence, i.e. how things exist across time, and so forth. The domain of discourse of formal ontology is, in principle, anything that exists (actually, possibly, necessarily, and for some, even those entities that are impossible) no matter what it is. For present purposes, formal ontology will be understood in reference to the domain of what I call things: spatio-temporal entities.

I present three of them here: mereology, mereotopology, and theory of locations.

The first is mereology, that is, the theory of part-whole relation and more in general of the composition theories. The second is mereotopology, i.e. the theory of connection. Mereotopology treats topology using mereology instead of set theory. Mereotopology provides an answer to the special composition question: some things compose something iff they are connected. The third is the theory of locations, that is, the study of the relation between entities and their location in space. Each of these formal systems is fundamental for understanding the nature of boundaries.

1.1 Mereology.

I'm typing on my laptop while I'm sitting on my bed. Are I and my laptop and my bed just one thing? In other terms: are I and my laptop and my bed, three parts of a larger whole?

According to most philosophers, we are all members of the same whole since composition is unrestricted. According to common sense, we are clearly distinct since we are discrete and only things fasten together compose a whole. Yet also a top and a slip are also discrete things, but nevertheless they compose a whole, namely a bikini.

The question, then, is: when does composition occur? When two or more things compose a further thing? Are there many ways of composing?

This and related questions are the ones that the research field of mereology studies[22].

Mereology is the branch of formal ontology that studies parthood, part-whole relations and the relations among parts.

It has a long history: the recent debates in logic, metaphysics and the philosophy of science can be traced back to Plato. Nevertheless, it was first explicitly formulated by Leśniewski only in 1916[23]. Nowadays, mereology is a central issue in the debate in ontology and metaphysics.

I set forth here an overview of mereology, oriented to the issue of the dissertation. I first introduce its basic predicates and axioms. I then discuss the operation of composition and the principal thesis about when it occurs.

1.1.1 Parthood: Core Principles.

There are many ways to set up mereology[24]. The most intuitive is to begin with the meaning of «part». The usual interpretation of parthood is as a two place relation whose meaning is established as a partial order: reflexive, transitive, and antisymmetric.

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[22] The *locus classicus* of contemporary mereology is Simons 1987. For a more recent and very nice introduction to mereology see Varzi 2016. For a less formal survey see McDaniel 2010. For the application of mereology to spatial issues see Casati and Varzi 1999, Varzi 2007, and Markosian 2014.

[23] For an introduction of the history of mereology see Burkhardt and Dufour 1991: 663-673.

[24] Which primitive relation should be used is controversial, yet is usual to employ part. Leonard and Goodman (1940), employed «overlap», namely having a part in common. Simons (1987) employed «proper part». For a list and motivations for using a different mereological primitive see Parsons 2014.

Stipulate P as the constant for parthood relation and let us assume a first order classical logic with calculus of predicates[25] and identity. Every formula is universally closed, unless otherwise specified.

P.1 Reflexivity

Pxx

Everything is part of itself.

P.2 Transitivity

(Pxy ∧ Pyz) → Pxz

Any part of any part of a thing is itself part of that thing.

P.3 Antisymmetry

(Pxy∧Pyx)→x=y

Two distinct things cannot be part of each other.

Each of the axioms has been source of debate[26], in spite of Simons 1987: 11 who wrote that «anyone who seriously disagrees with them has failed to understand the word [*part*]».

[25] Such an assumption is not controversial at all. Nonetheless, it is possible to formalize a mereology with a different underlying logic. For instance, see Weber and Cotnoir 2014 for a glutty logic. I return to this issue, since a different underlying logic is often employed in order to avoid the problems related to boundaries.

[26] For a survey of the critics against each of the axioms see Calosi 2011:33-38 and Varzi 2016: § 2.1. In brief, reflexivity is considered strange since assertions like «x is part of itself» seems to make no sense. That is because the meaning of mereological part is wider than the ordinary use of the word. Indeed, mereological part is a limit case of identity, as I shall shortly discuss. The ordinary use of the word "part" seems to be formalized with the mereological concept of proper part: x is part of y and x is not identical to y; transitivity seems to lead to an unbelievable consequence: if my finger is part of me and I am part of the doctoral school of Architecture and Environment, then also my finger is part of the school of Architecture and Environment. The strangeness of the consequence is due to the fact that we employ two senses of the word "part": in the first part of the assertion we employ a narrow sense, qualified as physiological part, whereas in the second part of the assertion the meaning of "part" is more general. Antisymmetry is the most controversial axiom, since it entails that sameness of parts is

1.1.2 Other Mereological Concepts

Using P as primitive other useful mereological predicates can be formalized:

Proper Parthood

$PPxy =_{df} Pxy \wedge x \neq y$

x is part of y, but y is not part of x

Underlap:

$Uxy =_{df} \exists z(Pxz \wedge Pyz)$

x and y are both parts of something

Overlap:

$Oxy =_{df} \exists z(Pzx \wedge Pzy)$

x and y have a part in common

Discreteness:

$Dxy =_{df} \neg Oxy$

x and y do not have a part in common

Proper Parthood is the notion that is closer to the usual usage of the word "part." It conveys the idea that a part is smaller than the whole which it belongs to. The reason to employ part as primitive instead of

sufficient for sameness in general. Consider a statue and a lump of clay which it is made of. They share all the same parts; nevertheless, they are different: the lump of clay can survive after it has been divided into pieces, whereas the statue cannot. The statue can survive the annihilation of one piece, whereas the lump of clay cannot. I return to this issue when I set up the extensionality theorem, which states that sameness of parts is both sufficient and necessary for sameness in general.

proper part is that part is algebraically more convenient (Simons 1987: 11; Parsons 2014: 6-11).

1.1.3 One Proper Part is not Enough.

As noted by Simons 1987, not every partial order is a parthood relation. Indeed, P.1-P.3 are satisfied by a model in which there is an object with just one part. It would be meaningless to speak of a thing with just one part. We have to rule out such a possibility.

If we want a system that is satisfied only by models that include composite things and then models that respect the ordinary meaning of the notion of part we need a further axiom. That is, if a thing has a part, then it must have another part. We need something that supplements the first part. Such an intuition can be formalized in various ways. Nevertheless the most common is the following:

P.4 Weak Supplementation:
$PPxy \longrightarrow \exists z\ (Pzy \wedge Dzx)$

The adjective «weak» is due to the possibility of strength supplementation, modifying the antecedent of Weak Supplementation:

P.5 Strong Supplementation
$\neg Pxy \longrightarrow \exists z(Pzy \wedge Dzx)$

P.5 is called «strong» for it entails P.4, in a model which also includes P.1-P.3.

Every mereology that includes the axioms of partial order and P.5 is called extensional, since it entails the following theorem[27]:

Extensionality:

$\exists zPPzx \longrightarrow (\forall z(PPzx \leftrightarrow PPzy) \longrightarrow x=y)$

The theorem claims that sameness of proper parts is sufficient for sameness in general. That is, being composed of the same parts means being the very same thing.

Despite the fact that extensionality seems uncontroversial, there are many arguments against it[28].

Some of the objections against it are related to the thesis known as «composition as identity» (CAI), i.e. the parts taken together are identical to the whole itself[29]. Despite the fact that CAI is a very ontologically parsimonious thesis, insofar as it avoids double counting, since it identifies parts with the whole (Lewis 1991: 80-83), it gives rise to a few worries. Some problems are due to the metaphysical implications of CAI; for examples, Lewis (1991: 81-87) and Sider (2007: 57) argue that CAI violates the indescernibility of identicals[30]. Moreover, Merricks (1992: 192-5) argues that CAI entails mereological essentialism, i.e. wholes have their parts essentially.

Solving such problems is beyond the aims of this dissertation; however, I assume extensionality of parthood for the sake of simplicity.

[27] See Simons 1987: 29 for the deductions.
[28] See Varzi 2016: § 3.2.
[29] For a great introduction see the essays in Baxter and Cotnoir 2014.
[30] Lewis was a proponent of CAI and thus he accepts it, nevertheless he shows that problem just to reject it.

1.1.4 Special Composition Question.

Mereology investigates the nature of things as parts and as complexes, i.e. things composites of more than one part.

Assume that two or more entities can compose something, according to a certain principle of composition, when each of those entities has a part in common with the whole they compose. Call such that mereological composition:

Composition:

$Fzxy =_{df} Pxz \wedge Pyz \wedge \forall w(Pwz \rightarrow (Owx \vee Owy))$

x and y compose z if a part of z overlaps either x or y[31].

When does it occur? When two or more entities fuse in a further one? In a more elegant way:

Special Composition Question (SPQ): What the necessary and jointly sufficient conditions for an entity being composed?[32]

The answer, then, has to take the following form:

Special Composition Answer (SCA): A thing is composed iff…

[31] I employ the predicate F since it stands for fusion, that can be understood as composition.

[32] It is a difference but equivalent version of the famous special composition question by van Inwagen 1990: 21-32.

There are many different answers to that question. Two or more entities fuse just when they are related by a suitable condition, whatever it is. Let us begin with the general formula of composition, that says that the entities that are in a certain way compose a whole. Formally:

$Fz\varphi w =_{df} \forall w(\varphi w \rightarrow Pwz) \wedge \forall v(Pvz \rightarrow \exists w(\varphi w \wedge Ovw)$

The entities that are φ[33] compose a further entity z.

The following formula represents the logical form of the suitable binary condition according to which two entities compose a further entity:

$\xi xy \longrightarrow \exists z(Fzxy)$

Is there any suitable condition that relates such entities? If any, what is such a suitable condition?

Let me briefly set up the two main answers to the question: universalism and nihilism. I then very briefly sketch the other answers to SCQ closer to common sense. In the next chapter, I introduce a way to restrict the composition employing boundaries. In the chapter devoted to denying *bona fide* boundaries I set forth a new answer to SCQ that resembles existential monism, i.e. the thesis according to which the universe is an undivided thing (Horgan & Potrč 2008)[34].

[33] φstands for every well-formed formula.
[34] They call their position «blobjectivism». The label "existential monism" is due to Schaffer 2010; 2016.

1.1.4.1 Universalism.

Classical mereologists claim that composition is unrestricted, namely, given every non-empty set there is always an entity composed of the members of that set (Lewis 1991; Van Cleve 2008; Varzi 2009). Therefore, there is a thing composed exactly of my nose and Nuraghe di Barumini.

More formally:

P. 6 Unrestricted Composition

$\exists w \varphi w \rightarrow \exists z Fz \varphi w$.

Every φw compose a further thing z.

Due to extensionality and Unrestricted Composition, members of every set compose at least one thing. And due to them they also compose at most one thing. That is, when the composition is unrestricted and the mereology is extensional, the composition is also unique.

Even though universalism is highly counterintuitive, its attractiveness is much more relevant for philosophers. Indeed, the so-called classical extensional mereology (CEM), i.e. the standard version of mereology, has as axioms just P.1, P.2, P.3, P.5 and P.6; all of the other axioms mentioned follow from that three as theorems (Lewis 1991)[35].

However, it seems more commonsensical, and perhaps more natural, to restrict composition on the basis on a criterion: cohesion, contact, teleology, and so forth. Speaking of a thing composed of my nose and Nuraghe di Barumini, seems at odds with our intuitions.

[35] For a more rich axioms set yet equivalent, see Sider 2007: 70, who includes in CEM P.1, P. 2, P. 4, P.5, P. 6, P.7.

Nevertheless, there is a famous argument developed for Universalism, first by Lewis (1986: 212-213), and then by Sider (2001: 120-139)[36]. I set up the argument here in a slightly different yet equivalent form:

1. Restricted composition has to be vague[37], in order to avoid arbitrariness. (A)
2. If there are case of restricted composition, then there are cases of vague composition. (from 1)
3. There cannot be vague cases of composition, since vagueness is a semantic fact, whereas composition is an ontological fact. (A)
4. Universalism is true. (from 2 and 3)

The argument try to prove that since composition cannot be vague, and every restriction of it has vague cases, then universalism is true, for it cannot be vague insofar as it admits every case of composition.

Although the argument seems to be compelling there are some philosophers who do not find it definitive. For instance, van Inwagen (1990)[38] argues against universalism in the following fashion[39]:

1. Assume CEM; (A)
2. $x_1,..,x_n$ composes y at t and y persists trough time; (A)
3. Since y persists trough time, then it can change its parts. At t_2 y is composed of $z_1,..,z_n$. (from 2)
4. $x_1,..,x_n$ there exist at t_2. (A)

[36] For a reconstruction of the argument, see Korman 2010.
[37] I return to the issue of vagueness in § 4.1. Assume now that x is vague iff there is something that is indeterminate whether or not it belongs to x.
[38] van Inwagen is not a nihilist, since he believes that there is something composed, namely organism. However, since he denies every other composite thing, he can be labeled as a local nihilist.
[39] My reconstruction based on van Inwagen 1990:75.

5. y at t1= y at t2, since they are the same entity and y at t≠y at t_1 since they are composed of different parts. (from 3 and 4)

The argument try to prove that if we assume the extensionality of mereology, then either we have to reject universalism or we have to accept mereological essentialism, i.e. the thesis according to which a thing cannot lose parts without also losing its identity. Either way, avoiding the contradiction has a high price.

1.1.4.2 Nihilism.

According to nihilists, composition does not ever occur. They depict a world populated by only mereological simples, i.e. proper partless things[40]. Therefore, there are no things such as cats, tables or molecules.

Formally:

$\forall y \neg \exists x(PPxy)$

However, nihilists are aware that composite things are the referents of most of ordinary talk and even of scientific talk. And, thus, they should find a way to permit such talk without any ontological commitment to composite things.

A very widespread way is to employ a paraphrase strategy of our talk. There are two kind of language: (i) a fundamental language and (ii) a superficial language. The fundamental language is supposed to paraphrase every ordinary sentence in a more fundamental one.

[40] I discuss in details the ontological and logical nature of simple in § 2.4.

Usually, the adopted paraphrase strategy works like this: when we talk about a composite thing, we are rather committed to «simples arranged so-and-so»[41]. For instance, when we talk about "cat," we can paraphrase such a name with the description «simples arranged cat-wise».

The arguments for nihilism are usually indirect argument against both composite things and a specific answer to SCQ.

The general argument against restriction of composition above can be usefully employed by nihilists in order to deny many variants of answers to SCQ.

1.1.4.3 Restriction of Composition.

Both universalism and nihilism are extreme answers to SCQ, too far from common sense, since people usually assume that there are composite things and there is no the sum of all the things there exist.

In the last few years there has been an increase in the number of moderate answers to SCQ, in order to restrict composition. The main options are:

- Hylomorphism: a thing is composed iff its parts are fastened together by special non-material force. That is, a thing is not just its material parts, but it also counts as parts its manner of composition (Fine 1999) or formal parts (Koslicki 2008).

[41] There are many different and reciprocally inconsistent ways of paraphrasing our sentences, avoiding any further commitment to composite things. The *locus classicus* is Van Inwagen 1990: 98-114. For a list and critics see Turner 2009: 3-54.

- Organicism: a thing is composed iff it is a living organism (van Inwagen 1990; Merricks 2001).

- Spatialism: a thing is composed iff the region in which it is located is composed (Markosian 2014)[42].

- Mereotopology: a thing is composed iff its parts are topologically connected. (Clarke 1981: 204-218; Casati and Varzi 1999: 51-70).

Developing each of these answers is beyond the scope of this dissertation[43]. I will only briefly outline some of the basic axioms and notions of mereotopology, in order to explicate better the answer given by positing boundaries.

1.1.5 Some Further Assumptions.

Parthood is usually understood under the following three further assumptions (Sider 2007: 70):

P_a Absoluteness: Parthood is a two-place relation; it does not hold relative to times, places, sortals, or anything else[44].

[42] Markosian (2014: 73) does not give an answer to SCQ, rather he dictates the conditions under which a thing is part of another.
[43] Let me just mention that Markosian 1998 argues for composition as a brute fact.
[44] In order to avoid some problems due to persistence through time and time travel, there are some philosophers who have modified the adicity of parthood, e.g. three place with a time index; four place with a time index and a region index; four place with an index for the region of part and an index for the region of the whole.

P_b Mereological monism: There is a single (fundamental) relation of parthood, which applies to all objects, regardless of ontological category[45].

P_c Precision: 'is a part of ' is not a source of vagueness[46].

I assume each of them for the sake of simplicity.

1.2 Mereotopology.

Consider a bikini and a building. Both are wholes, yet it seems that they are wholes in two different senses: the first is the sum composed of two discrete things, i.e. the top and the slip, and the second is a sum of connected things, i.e. some bricks. A bikini is a scattered whole, whereas a building is a self-connected whole. Formalizing such distinction is the business of mereotopology.

Mereotopology can be defined as an autonomous branch of formal ontology whose aims are to characterize mereologically topology, instead of using set theory. This second definition of mereotopology is ontologically neutral insofar as it does not give any particular answer to

[45] Some versions of mereology dictate that every ontological categories must have its own parthood relation, e.g. one for material objects, one for regions, one for events, and so on. McDaniel 2010: 451 suggests two forms of monism and two forms of pluralism: (i) strong monism: there is one parthood relation and it is not analyzable in term of other relations or properties; (ii) weak monism: there is one parthood relation and it is analyzable in term of other relations or properties; strong pluralism: there is more than one fundamental parthood relation and they are not analyzable in term of other relations or properties; weak pluralism: there is more than one fundamental parthood relation and they are analyzable in term of other relations or properties

[46] There are two ways in which mereological vagueness can be characterized: (i) parthood is vague; (ii) mereological composition is vague. Such assumption is connected to Universalism, as Sider argues.

SCQ: two thing can be connected without composing a whole. It is thus silent about the number of things that populates the world.

In what follows I set up the predicates and axioms of mereotopology, by means of which I later characterize boundaries[47]. I first introduce topology and the way in which it can be characterized in mereological terms. I then set up the qualified version of mereology due to topology.

1.2.1 Basic Principles.

Topology is usually presented as the theory of qualitative approach to space. It gives rise to the resources to qualify the behaviors of things in space and their relations.

Assume C as the predicate "connect", as primitive. Stipulate also that C is reflexive and symmetric.

Reflexivity

Cxx

Everything is self connected.

Symmetry

Cxy⟶Cyx

If x is connected to y, then y is connected to x.

As Casati and Varzi 1999 claim, we can obtain a bridging principle between topology and mereology via the following axiom:

[47] The main sources of this chapter are Casati and Varzi 1999: 51-62 and Varzi 2007: 991-1006, although some of the definitions I state are slightly different. For a further different and not equivalent characterization see Cartwright 1975 and Clarke 1981.

$Pxy \rightarrow \forall z(Cxz \rightarrow Czy)$

When x is part of y, every thing that is connected to x is also connected to y.

By means of that definition one can also characterize a definition of self-connected whole, i.e. a whole of which every part is connected. Assume that cw stands for the w that are connected.

Connected Composition

$CFzcw =_{df} \forall w(cw \rightarrow Pwz) \wedge \forall v(Pvz \rightarrow \exists w(cw \wedge Ovw)$

As I noted above, one can give an answer to SCQ via connection:

$Cxy \longrightarrow \exists z(Fzxy)$

What about the second case? How can we characterize the second kind of relation?

Touching happens between two discrete entities when anything lies between them and nevertheless their regions are connected, i.e. both belong to the same space. I return to this issue later.

1.2.2 Qualified Parts.

Since underlap is defined via parthood, we can hence qualify mereological predicates by means of connection (Casati and Varzi 1999: 55; Varzi 2007: 982).

Internal Part

$IPxy =_{df} Pxy \wedge \forall z\ (Cxz \longrightarrow Ozy)$

x is an internal part of y when every z that is connected to x overlaps y. For instance, every thing is connected to Umbria, also overlap Italy.

Tangential Part

$TPxy =_{df} Pxy \wedge \neg IPxy$

x is a tangential part of y when despite of x is part of y, not every thing connected to x overlap y. For instance, Valle D'Aosta is part of Italy and it is connected to France, but France does not overlap Italy.

Internal Overlap

$IOxy =_{df} \exists z(IPzx \wedge IPzy)$

x and y internal overlap when two of their interior part overlap. For instance, Umbria and Italy overlap since an interior part of Italy, i.e. its Center, overlaps with the whole Umbria.

Tangential Overlap

$TOxy =_{df} Oxy \wedge \neg IOxy$

x and y tangential overlap when either an external part of x overlaps an external part of y, or an external part of x overlaps an internal part of y. For instance, a lake and one of its affluent external overlap since the last part of the affluent has arguably a part in common with the first part of the lake.

If the intended interpretation of mereology is extensional and the composition is unrestricted the algebra of mereology is isomorphic with a Boolean algebra, without the null set. By means of that other useful topological notions can be defined. Before defining them, consider the following basic mereological operators. Where σ stands in place of set abstraction.

Difference

$x\text{-}y =_{df.} \sigma z(Pzx \wedge \neg Ozy)$

the biggest thing that overlaps x but is discrete from y.

Sum

$x+y=_{df.} \sigma z(Pzx \vee Pzy)$

the biggest thing that overlaps either x or y.

Product

$x \times y=_{df.} \sigma z(Pzx \wedge Pzy)$

the smallest thing that overlaps both x and y.

Complement

$\sim x =_{df.} \sigma z(Dzx)$

the thing that does not overlap x.

By means of them instead of set theoretical operators, we can define the following topological operators:

Interior

$ix =_{df} \sigma z IPzx$

The interior of x is the sum of all its interior parts. For instance, the interior of Italy is its regions taken together.

Exterior

$ex =_{df} i(\sim x)$

The exterior of x is the interior of its complement. For instance, the exterior of Italy is every thing that is not one of its regions.

Closure

$cx =_{df.} \sim(ex)$

The closure of x is the exterior of its complement. For instance, the closure of Italy is its border and its regions.

Boundary

$b(x) =_{df} \sim(ix+ex)$

The boundary of x is the complement of its interior and its exterior. For instance, the boundary of Italy is its national border[48].

It can be also useful to characterize things and regions on the basis of the presence of boundaries:

[48] Actually, nations share they exterior borders. For the sake of explanation, let us assume that every nation owns its border.

Open

$OPx =_{df} x = ix$

x is open when it does not own its boundary.

Closed

$CSx =_{df} x = cx$

x is closed when it owns its boundary.

1.3 Theories of Location.

I'm located in Italy right now. I'm in a certain sub region of Italy and in a certain sub region of that sub region, of which Italy is its super region.

Is there a difference between the location relation I have with Italy and the location relation I have with the region of space as big as my body?

That is one of the questions which theories of location aim to ask. Explicitly, theories of location have to ask:

(i) what does it mean that x is located at y?
(ii) should x mirror the mereological structure of y?
(iii) how many disconnected regions may be occupied by x?
(iv) how many distinct things can a region host?
(v) is any region of space a possible receptacle?

The first question is about the logical and ontological status of location. The second question is about what is called «mereological harmony» or «mereological mirroring». The third question is about

multi-location. The fourth question is about the possibility of lower dimensional entities, e.g. points, lines, surfaces.

I briefly sketch a model that can offer answers to questions (i) and (ii). I face question (v) in chapter 2 and questions (iii) and (iv) in §4.5[49].

1.3.1 Location Relation.

The relation between a thing and its region can be thought of as the perfect matching of the volume of the first with the volume of the second. Thus,

x is located in y iff x has the same shape, size and topological relation as y.

Such a principle can be formalized using L as primitive of our system. Via L we can define other useful location principles:

Weak Location

$WLxy =_{df} \exists z(Ozy \wedge Lxz)$

Conditional Location

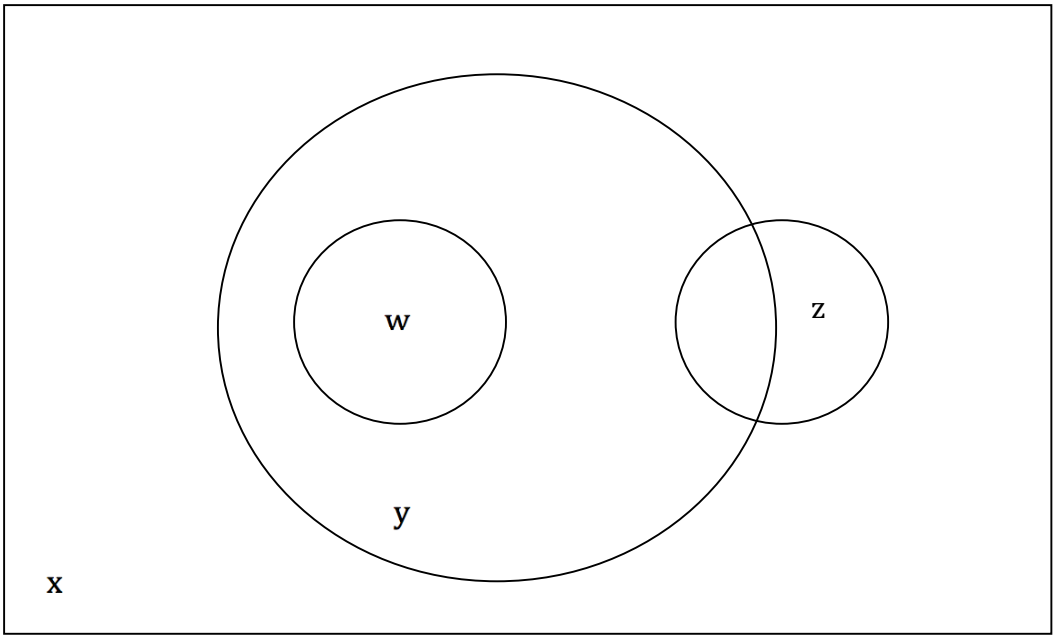
$CLxy =_{df} \exists z(PPzy \wedge Lxz)$

Strong Location:

$SLxy =_{df} \exists z(Uzy \wedge Lxz)$

[49] For a very nice introduction see Gilmore 2014: § 2 and § 3. For the standard theory of location see Casati and Varzi 1999: 117-136, for a non standard one see Parsons 2007: 201-232.

I'm located in the region that coincides with the size and shape of my body. WL (Parsons 2007: 203) stands for the weakest sense of location: I'm weakly located in a region that is not completely free of me. I'm weakly located in Sassari and also in the sub region occupied by my head. CL says that I'm located in a sub region of a bigger region. I'm conditionally located in Sardinia but I'm not conditionally located in the region of my whole body. SL says that I'm located in a super region of the considered region. I'm located where my body is and thus where my head is located.



	x	y	w	z
x	L/WL	SL/WL	SL/WL	SL/WL
y	CL/WL	L/WL	SL/WL	WL
w	CL/WL	CL/WL	L/WL	
z	CL/WL	WL		L/WL

Read as the letters in the right column as the first argument, while the letters in the line as the second argument.

2. Boundaries.

> "But this is not ignorance. We don't know the boundaries because none have been drawn."
> Ludiwig Wittgenstein, *Philosophical Investigations*

In this chapter, I present a critical introduction of boundaries. Here, I take them as truly belonging to the furniture of the world and, thus, as located in space, according to my definition of "thing", i.e. occupant of regions. Then I work assuming the following two clauses:

1. Boundaries exist.
2. Boundaries are *bona fide* entities[50].

I think taking them seriously can be a good starting point for every metaphysics of space or, more generally, of material world. Nevertheless, boundaries have been strangely neglected in the recent history of metaphysics. Despite metaphysicians' attempt to carve nature at its

[50] In chapter 5 I better explain exactly what *bona fide* means. Here let us just assume that *bona fide* corresponds to human- independent, i.e. things that would also have existed without humans' concepts, languages and conceptual schemes. For instance, a wedding is not a *bona fide* thing since it needs humans' concepts such as relationship, promises, love and so forth. Whereas a table, despite its being a product of human's work is independent since it would exist even if humanity were to be extinguished.

joints, i.e. at its human- independent boundaries, there are few direct studies on the nature of boundaries in the last fifty years. Not even those metaphysicians who work on spatial issues, such as composition, constitution, location, mereology, the simples-gunk debate, and so forth, pay great attention to boundaries[51]. As I explained in the introduction in § 0.4, boundaries are not important only to these topics; they may also have a role in many metaphysical disputes.

In what follows, I first formalize a coherent definition of boundaries that is consistent with our intuitions. I set forth a survey of the common definitions in the literature simply to reject them. I finally present my own definition. Then, I introduce the main intuitive and non-controversial features of boundaries and their mutual relations. Some of them have to be taken as axioms and others as corollaries or theorems. I explain each of them and eventually the relation between boundaries and things they bound.

In what follows, I outline a theory of boundary consistent with common sense and our shared intuitions. I think that the philosophical theory in chapters 4 and 5 are closer to our best scientific theories.

2.1 Towards a Definition.

Let me begin with a very intuitive notion, the one I assume and the one I guess all of us employ in speaking about boundaries.

B1$=_{df.}$ x is a boundary of y iff x is the last part of y.

[51] For instance, the entry "Location and Mereology" (Gilmore 2014) of the *Stanford Encyclopedia of Philosophy* never mentions boundaries. Nevertheless, see the nice entry "Boundary" by Varzi 2014.

Common sense defines boundaries as the outermost parts of a thing or of a part of a thing. That is, every part of that thing is not beyond the boundaries and every thing beyond the boundaries is not part of that thing.

This definition has already been stated by Aristotle in his *Metaphysics.* According to him (1984: V, 17, 1022a4–5), a boundary of x is «the first point beyond which it is not possible to find any part [of x], and the first point within which every part [of x] is». It is not enough, as Sorensen 1998: 275 argues. Suppose the universe, i.e. the thing of which every other thing is a proper part, is finite. It has surely a last part but nevertheless it has no boundaries since we usually assume that boundaries have to demarcate the difference between a thing and its surrounding. And the universe, by definition, has no surrounding[52]. Then we have to supplement B1 with one more clause.

B2$=_{df.}$ x is a boundary of y iff x demarcates y from its surrounding.

Then we obtain the following comprehensive definition of boundary:

B$=_{df.}$ x is a boundary of y iff x is the last part of y and x demarcates y from its surrounding.

Such definition, although intuitive, is still not precise. There are few different not equivalent ways in which the definition may be stated in a more formal fashion[53]. In the literature there are at least three ways to

[52] In a world without a universe B1 entails B2. The proof is trivial.

[53] Boundaries can be also defined as not belonging to a thing, but instead as being independent of things. That is, a boundary may be a thing that lies between two discrete things. Consider the boundary line between Italy and France, it is clearly not a property of just one of them; rather it is a thing that does not belong to either. Consider the classic example of Leonardo da Vinci's(1938), who asks which is the owner of the boundary

do it. The first is the classic way proposed by Cartwright 1975[54], who defines boundaries as shared points; the second was proposed by Brentano 1988, Chisholm 1983, 1989 and Smith 1997, who define boundaries as things that can coincide; and the third was proposed by Smith 1993 and Casati and Varzi 1999, who define boundaries as things that straddle the bounded one. I strongly believe that each of them has to be rejected. In what follows, I outline some reasons to deny them, and then set forth my own definition.

Let me briefly state a few constraints for the formal definition:

(i) It has to be as much as possible coherent with the non-formal definition[55].

(ii) It has to be necessarily valid for every boundary that may exist.

(iii) It has to be non- trivial, i.e. it has to be informative and substantial[56].

It may seem that (i) and (iii) are contradictory. But it is not so, since adding information is not a violation of coherence with a more succinct definition.

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that divided the sea from the sky. Here it also seems the answer is none of the two. In recent years this view was supported only by Hestevold (1986). But the view is not compelling at all since it seems that there is a third thing among the two. Each of the two are in contact with such a third thing, i.e. nothing lies in between. If one assumes that boundaries divide a thing from its surrounding then it entails that there is a boundary that divides each of the two from that third thing. Therefore, each of the things has a boundary.

[54] The definition is adopted by Hudson 2001, 2005; Kilborn 2007; Markosian 2000.

[55] The condition implicit assume that the non-formal definition is close to common sense, namely what I want to follow here.

[56] It is difficult state what non- trivial means. I assume here that a formal definition is informative iff it contains more details about the *definiendum* than the non- formal definition one has to formalize. That is, it clarifies the basic structure of the *definiendum*. For this line of thought, see the example of the supplementation axiom for mereology in Simons 1987: 26-29 and Varzi 2016: § 3.1.

2.1.1 Boundaries, Points, and Open Spheres.

In his classic pseudo-topological treatment of boundaries, Cartwright (1975) defines them, in a quasi-formal fashion, as common points between two otherwise discrete things. In his words:

CB=$_{df.}$ «A point p is said to be a boundary point of a region A iff every open sphere about p has a non-null intersection with both A and the complement of A […] p is a boundary point of A just in case every open sphere about p has in it points of A and points of the complement of A» (Cartwright 1975: 154)

OS=$_{df.}$ «By an open sphere about p is meant a region the members of which are all and only those points that are less than some fixed distance from p. In other words, a region A is an open sphere about the point p if and only if there is a positive real number r such that A is the set of all those points whose distance from p is less than r» (Cartwright 1975: 153)

That is, given two discrete things x and y, z is the set of its boundary points iff the points of z belong to, i.e. are proper parts of, both x and y. The first way to formalize the intuition is then the following:

Bx*=$_{df.}$ cx+c~(x)

The boundary of x is the intersection of the closure of x with the closure of its complement

But such a formalization is still too rough, since it is general enough to include a definition inconsistent with the one by Cartwright. Consider the following:

$CBx^{*}=_{df.}$ In a gunky space the boundary of x is the non-null intersection between the closure of x and the closure of the complement of x.

Gunky Space$=_{df.} \forall x \exists y PPyx$
Every thing has a proper part.

This scenario clearly rules out the definition by Cartwright since in a gunky world there are no points.

In order to formalize exactly what Cartwright means we need a quasi -metric space that assumes the notion M of distance as primitive. According to the treatment by Di Concilio and Gerla 2006 and Coppola and Gerla 2014, the notion M is regimented by means of the following axioms:

M1: $Mxx=0$

M2: $Mxy \leftrightarrow Myx$

M3: $Mxy \leq Mxz + Mzy$

M4: $(Mxy=0) \leftrightarrow x=y$

That is, according to M1 every thing is at distance 0 from itself. According to M2 two things are divided by the very same distance.

According to M3, also known as triangular inequality, the distance is a transitive relation. According to M4, when the distance between two things is zero, then the two things are the same. It can be seen as an axiom of extensionality and a ban to colocation[57].

The formalization of the concept of open sphere is now straightforward:

$OSxy =_{df.} OPx \wedge \forall zPPzx \rightarrow (Mzy \prec b)$

An open[58] sphere x about point y is the set of those points that are located at less than some fixed distance b from y.

$CBxy =_{df.} \forall zOSxz \rightarrow (Pzy \wedge Pzw \wedge Dyw)$

x is a boundary point of y iff every open sphere about x is part of both y and the complement of y.

Thus, the boundary of a thing is the set of all its boundary points. Although that definition of boundary seems to meet all the desiderata, it has some very controversial corollaries. Let me list two of them and then critique them one by one.

CB1. Every point of x may be a boundary point of x
CB2. It rules out a universe with just one thing.

Consider CB1. Take a point y located in the interior of a closed sphere x whose radius is n. Take an open sphere z about y whose radius is n+1.

[57] For extensionality see § 1.1.4, for colocation see § 4.5.
[58] Something that does not own its boundary part, see § 1.2.2.

Since the open sphere z has a radius greater than x, its center point y is a boundary point of x despite the fact that it is located within the interior of x. But the definition of boundary point states that every open sphere about a boundary point has to intersect the complement of the bounded thing. And it seems not to be the case, for there are open spheres about y smaller than x: not every open sphere about y intersects the complement of x. Therefore y cannot be a boundary point of x. Consider a verisimilar scenario in which x is the smallest sphere of a world. It means that there is no possible sphere smaller than x in that world. It is not controversial at all that x is composed of points for points are smaller than any possible sphere. In that scenario any point y of x is one of its boundary points since any open sphere about y turns out to have a radius greater than the radius of x. Therefore, interior points of x may be boundary points of x. It is a highly controversial conclusion and it not do justice to our intuitive notion that a boundary is the last part of a thing.

Consider CB2. Take a boundary point y of a closed sphere x located in an otherwise empty world. Every open sphere z about y would have among its points the points that are located in the interior of x. But since there are no other things in the world, z cannot have points that do not belong to x. Therefore, x has no boundary points. Contradiction.

Moreover, CB is circular. Cartwright and his acolytes define boundary points by means of the notion of open sphere. An open sphere is defined by means of the notion of openness. A non- trivial characterization of openness has to employ the notion of boundary[59]. Indeed, an open thing is a thing that lacks boundaries among its parts. We therefore need a notion of boundaries in order to give a correct characterization of openness. Thus, the definition proposed by Cartwright is circular.

[59] The charcterization of open thing I gave in 1.2.1 is clearly elliptical since it just states that an open thing is identical to its interior, namely it has no boundary.

2.1.2 Boundaries as Coincident Things.

Boundaries can be defined as those parts of a thing that own a particular property. Along this line of thought one can find the definition proposed by Brentano 1988, which was refined by Chisholm 1984 and eventually formalized by Smith 1996.

According to them, boundaries are things that depend upon a thing as a matter of necessity and, more importantly, boundaries are the only things capable of coincidence, i.e. sharing a region without sharing parts with a further thing. For the moment, I do not investigate dependence since it will be the topic of a further paragraph.

Let me state some axioms that define the primitive coincidence COI following the formalization proposed by Smith[60].

COI1: $COIxy \rightarrow COIyx$

If x coincides with y, then y coincides with x.

COI2: COI: $(COIxy \wedge COIxz) \rightarrow COIyz$

If x coincides with y and with z, then y coincides with z.

One more axiom states that coincident things coincide with themselves.

$SCOIxy =_{df.} \Diamond COIxy \rightarrow (COIxy \wedge x \neq y)$

If it is possible for x to coincide with a thing then x also coincides with itself.

[60] I formalize using different conventions, but the formula is to be taken as equivalent.

The definition of boundaries states that boundaries are all and only those things that may coincide.

$BBx =_{df.} \Diamond(COIxy \wedge Dxy)$

x is a boundaries if it possible that it coincide with something discrete[61].

I have a few worries about that definition of boundaries. First, Chisholm and Smith state an axiom that rules out the possibility for things, which they call bodies, to be coincident. Thus, only boundaries can coincide with each other. Such an axiom would prevent interpenetration, i.e. the possibility for two discrete things to share their region. Nevertheless, it seems arbitrary and also false. It seems arbitrary because there is no sufficient reason to rule out the possibility of interpenetration for some kinds of entities and not for other kinds. And given that the model proposed by Chisholm and Brentano and formalized by Smith does not count among its members lower dimensional things, such as points, lines and surfaces[62], it is even more unjustified, since such things can exist in at least a possible world.

The axiom seems false since, as Zimmerman 1996 and Sider 2000 puts it, it is easily provable that interpenetration between two discrete bodies is ruled out just by the physical laws of our world and thus is not a matter of metaphysical necessity[63]. Suppose a world with no physical law that prevents interpenetration, that is, a world where there is no repulsive force that prevents interpenetration. Consider there a three-dimensional path that goes from A to B. In A is located Reddy, a red cube of volume v^3

[61] Giving extensionality it is provable that SCOI and BB are equivalent.
[62] Actually, they assume a notion of pseudo point that does not lack proper parts.
[63] I face directly the problem of interpenetration in § 4.5.

made of stuff m. In B is located Blully, a blue cube of volume v^3 made of stuff m. If Reddy and Blully move to the center of the path at the same time and no further force or event prevents their interpenetration, then they interpenetrate. Therefore, an *a priori* axiom is not sufficient for preventing interpenetration.

The second worry concerns the relation between a thing and its boundary. Assume BB is valid. Then, a thing has an outermost skin of pseudo point that can be coincident with the skin of a further thing. If one want avoid vagueness, one has to find a precise boundary between the boundary of a thing and the thing itself. Also that new boundary has to be capable of coincidence. Then, it must be a new boundary between the boundary between the thing and the boundary itself. Since no one of them is lower dimensional, due to the constraints by Brentano and his acolytes, it turns out that the whole thing is capable of coincidence. But this is a contradiction with the notion of thing given by Brentano.

The third worry regarding the problem of formalism: Is it a good way to represent the commonsense notion? Unless it is assumed that just boundary parts may be capable of coincidence, and as I have argued, this is highly controversial, there is no reason to belief that the definition is about the last part of a thing.

2.1.3 Straddling Boundaries.

The last strategy I consider is the one proposed by Smith 1993, Casati and Varzi 1999 and Varzi 2007. At a first look, their strategy is pretty general and thus it seems to be not substantive.

To introduce their notion we need to formalize two more mereological predicates: over-crossing and straddle.

$OXxy =_{df.} Oxy \wedge \neg Pxy$

x and y overlap but no one is part of the other.

$Sxy =_{df.} \forall z(IPxz \rightarrow OXzy)$

x straddles y iff every neighborhood of x, i.e. everything including x as an interior part, over-crosses y.

By means of S, they define boundary as follows:

$VBxy =_{df.} \forall z(Pzx \rightarrow Szy)$

x is a boundary of y iff every thing that includes x as interior part, straddles y.

That is, boundaries are something in between the bounded thing and its interior. The main virtue of VB is that it does not entail that a boundary is part of the bounded thing but it also does not deny it. We shall see that it may be an advantage in § 2.8.

Nevertheless, there is at least one counterexample to it that seems to me may be fatal. Consider a world inhabited only by an extended simple E, i.e. a proper partless thing located in a region greater than a point[64], coated by an extended simple skin S. One can say truthfully that S is the boundary of E despite the fact that everything fails to include S among its interior parts and then S is not described by VB. A supporter of VB can reply that in that case VB is vacuously true. Fair enough. Yet VB does not describe boundary in that case; indeed, it seems that VB is able to describe many different situations. Therefore, VB fails to describe every situation involving boundaries.

[64] See § 2.4 for a complete characterization of simples and extended simples.

2.1.4 Boundaries as Dividers.

I state a formal definition of boundary that should be exempt from all the counterexamples I present so far.

$Bxy =_{df.} TPxy \wedge \forall z(IPzy \rightarrow (Ozx \vee \exists w(Owx \wedge Oxz))$

x is a boundary of y iff x is a tangential part of y and every internal part of y either overlaps x or overlaps something that overlaps x.

The definition states that a boundary is the last part of a thing and everything that does not belong to such a thing fails to lie within the outline drawn by the boundaries.

It does not dictate the dimension of the thing and it is perfectly compatible with a gunky world, unlike CB. It is not arbitrary, unlike BB. It is not incompatible with an empty world but a considered thing, unlike VB. It does not violate any of the *desiderata* of the definition.

Moreover, since parthood is antisymmetric, when two things share their boundary such things are the same.

The main advantages of my definition are the ideological and ontological parsimony. Let me briefly explain what they are and then demonstrate why my proposal is better than the others in these respects.

Any theory has what is called «theoretical commitment» (Cowling 2013): on the one hand, it is composed of every undefined terms it employs in order to reach its aim, on the other, it is composed of every entity it posits in order to be true. For instance, Peano arithmetic is committed to successor function and number zero by means of which it

can define all the other components of the theory. It is also committed to the existence of numbers as real things, in order to be true[65].

This first commitment is called ideological, i.e. the set of the primitives employed by which the theory can define all the others. The second commitment is called ontological, i.e. the set of the things a theory posits in order to be true.

A theory is parsimonious iff it minimizes its commitments. It can ensure that task in two distinct not equivalent ways: quantitatively, i.e. reducing the number of the commitments; qualitatively, i.e. reducing the number of the kinds of commitments.

A theory thus may be:

(i) quantitatively ontologically parsimonious iff it reduces the number of things it posits. E.g., mereology is more parsimonious than set theory. For mereology posits just the existence of the things, whereas set theory adds the existence of sets.

(ii) qualitatively ontologically parsimonious iff it reduces the kinds of things it posits. E.g., nominalism is more parsimonious than Platonism. For nominalism posits only the existence of *concreta*, whereas Platonism adds the existence of *abstracta*.

(iii) quantitatively ideologically parsimonious iff it reduces the number of primitives. E.g., Euclidean Geometry under Peano's axioms is more parsimonious that Euclidean Geometry under Hilbert's axioms. For Peano posits as undefined notions only motion, segment, and point, whereas Hilbert assumes line, plane, point, betweeness, congruence, and incidence.

(iv) quantitatively ideologically parsimonious iff it reduces the number of kinds of primitives. E.g., Quine's quantifications are more

[65] Assume that for the sake of simplicity. In part two, I explain how a theory can also be true with a fictional commitment.

parsimonious than Hirsh's quantifications. For Quine assume two quantifiers, ∃ and ∀, with a fixed meaning, whereas Hirsh's quantifiers vary in meanings on the basis of contexts.

I claim that my definition is parsimonious in every sense of the term, whereas all of the others fail in at least one of these senses.

I illustrate in the following scheme how my definition is parsimonious with respect to all the others. In the column on the left I list the names of the other definitions and in the top line the various kinds of parsimony. I mark the symbol "+" when the considered definition is richer than mine and with the symbol "=" when they have the same number of commitments.

	Quantitative Ontological Parsimony	Qualitative Ontological Parsimony	Quantitative Ideological Parsimony	Qualitative Ideological Parsimony
CB	+	=	+	+
BB	+	=	+	+
VB	+	=	=	=

CB posits a richer ontology for it posits the existence of points as fundamental for stating the theory, whereas B works as well as in a gunky world, i.e. a pointless world. CB also has a richer ideology for it employ more primitives and more kinds of primitives.

BB has a greater quantitative ontological commitment for it entails the existence of things with the particular properties of being coincident. It also has a richer ideology in so far as it employs new predicates for coincidence.

VB is the more similar to B, except that it posits the necessity of a non-empty world, whereas B does not need plenitude in order to be true.

2.2 Three More Theses.

The definition is clearly not enough to characterize the nature of boundaries. Therefor, let me claim three more non- controversial theses about them.

(i) Boundaries ontologically depend upon the bounded thing (e.g., Chisholm:1983; Correia 2008: 1015; Casati and Varzi: 96; Varzi 2007: 995; Smith 1996: 295).

(ii) Boundaries have one fewer dimension than the bounded thing (Chisholm 1984; Simons 1991; Smith 1997; Zimmerman 1996: 15; Galton: 2007; Varzi 2015:1.4).

(iii) When a boundary undergoes any operation, then the bounded thing undergoes such an operation. (e.g., Stroll 1988: 21-22; Smith 1997; Sorensen 1998).

Thesis (i) claims that it is impossible for a boundary to exist without the bounded thing. Suppose the two dimensional surface of a table, it clearly cannot be detached from the table, otherwise it would exist as a two dimensional layer with one face. It seems impossible. Thesis (ii) claims that if an object has n dimension, then its boundary has one dimension less, otherwise it also may have a further boundary. E.g., the boundary of a three dimensional thing is a two dimensional surface. The boundary of a two dimensional surface is a one dimensional edge, and so forth. Thesis (iii) maintains that what happens to boundaries involves the whole thing, e.g., being touching, being seeing, being painting, and so forth.

If we combine such theses with the general definition of boundaries and the uncontroversial assumption that a world contains more than one thing, we reach very interesting results.

I face each of the results in the following paragraph. Let me briefly list the results of the various combinations and then give some more details one by one.

2.3 The Problem of Inheritance: (ii)-(iii) jointly entail that a thing inherits every operation that a boundary undergoes and the falsity of the converse.

2.4 The Problem of the Bulk: (ii)-(iii) jointly may seem to entail a contradiction (when the antecedent is true): a two dimensional surface lacks material bulk but it can undergo some material operations.

Furthermore, B2 together with the assumption that the world in not empty, whatever formalism we chose, entails interesting outcomes:

2.5 On the Number of Boundaries: B2 entails that (a) where there is a boundary, there is a thing and (b) *pace* Stroll 1987, every thing has at most one boundary.

2.6 Things Depend Upon their Boundaries: B2 and (i) jointly entail a contradiction: (B2) states that x exists as a thing since it has boundaries. It may seem that x depends upon its boundaries. But (i) states that boundaries depend upon the bounded thing: it seems absurd to try to detach a boundary from the thing it bounds. This is a contradiction.

2.3 The Problem of Inheritance.

Let us consider once again Reddy, a red cube of volume v^3 made of stuff m. Let us take whatever possible operation that can be performed upon the surface of Reddy, i.e. its boundary. According to (iii) each of these possible operations is also performed upon Reddy. Instances may be: painting, scratching, polishing, cleaning, seeing, touching, and so forth.

The converse does not clearly hold due to (ii). Indeed, since the whole cube has one dimension more than its surface, it may be subject to more operations than its surface: rolling, bouncing, cruising by, and so forth.

Although (iii) seems obvious, Stroll 1988: 21 dictates an important constraint to it. He argues that not every operation performed upon a surface is an operation performed upon the whole thing. For instance, certain intensional activities such as «admiring the surface of Reddy» are not performed upon Reddy but only upon its surface. Suppose Stroll is right. Then, there would be a possible way of admiring the surface of Reddy, without admiring Reddy. But since according to B the surface of Reddy is a part of Reddy we are admiring a part of Reddy, perhaps regardless the remainder. However, Reddy is in a certain sense admired: it is admired in one of its parts and since Reddy is every one of its parts jointly taken whatever principle of composition you prefer, Reddy is admired. Indeed, if we detach the surface of Reddy, every new operation after the detachment is not performed upon the surface of Reddy, but upon a two dimensional thing that was the surface of Reddy. Therefore, every operation, even intensional, is performed upon Reddy.

2.4 The Problem of Bulk.

Suppose you kick a ball against the surface of Reddy. Then you expect that the ball bounces off the surface right back to your feet. Arguably, and according to (iii), the ball bounces not only against the surface but also against the whole Reddy. Recall (ii) the boundary of a thing is one dimension fewer the whole thing; then in the relevant case the surface is two dimensional and, thus, it lacks material bulk. How is it possible for a bodiless thing to be causally efficacious[66]?

Stipulate, for the sake of simplicity, a counterfactual analysis of causation: «x causes z, iff had x not occurred, z would not have occurred». Suppose x is the surface of Reddy and z is the bouncing of the ball. Consider two possible worlds, w_1 and w_2. Reddy is one of the members of w_1. Whereas Reddy* is the counterpart of Reddy in w_2. Reddy and Reddy* share all the same properties and proper parts but the surface x. Apart from this detail, w_1 and w_2 are perfectly Lewisian duplicates[67]. Consider the following couple of situations. In w_1 I kick the ball against Reddy and it bounces against x. The bouncing of the ball z has a certain trajectory t and speed v. In w_2 my counterpart I* kicks the ball against Reddy and it bounces against some outermost part of Reddy*. The bouncing of the ball z has a certain trajectory t* and speed v*, where t*=t and v*=v since Reddy and Reddy* share the same mass, volume and all other physical properties and given (iii). In fact, Reddy and Reddy* are not physically dissimilar, even though Reddy* lacks x, since x lacks mass

[66] For nice introductions to the topic see Morena 2002; Varzi 2015: 1.4. For criticism Zimmerman 1996.

[67]«x and y are perfect duplicates just in case they and their parts can be put into a one-to-one correspondence that preserves the facts about which perfectly natural properties and relations are instantiated» (Hall 2016: 3)

and volume. In this case, we have a relevant counterexample to counterfactual analysis: z would have happened even if x had not existed.

Therefore, either the counterfactual analysis of causation is wrong or boundaries do not have causal power. The first disjunct does not seem compelling, since one can replace whatever analysis of causation with the counterfactual one and obtain the same outcome: lacking surface is not causally relevant. The second one seems more promising and in accordance with our intuitions. The problem is that realism about boundaries entails the very controversial thesis according to which not every spatial thing is causally efficacious. It also entails the even more controversial thesis according to which if boundaries exist, then necessarily there exists something not causally efficacious.

Unless one does not find that result uncomfortable, there are three ways in which the problem may be solved:

- Bodiless Things are causally efficacious (Braddon-Mitchell and Miller 2006; Hudson 2005): there are lower dimensional things that interact with the higher dimensional ones. As Braddon-Mitchell and Miller puts it, there are little two-dimensional squares that are Planck length and they lack proper parts. Boundaries may be conceived by analogy as middle size squares or lines. Moreover, Hudson 2005 argues that a thing with surface is larger than a thing without it. Consider two otherwise indiscernible spheres with the same radius r: the first has a surface and the second lacks one. Consider a spherical shell of radius r. Since the second sphere lacks surface it can easily fit in the shell, whereas the first one cannot fit within the shell unless co-location is admitted.

- Bodiless Things are abstractions (Whitehead 1917; Clarke 1985; Zimmerman 1996): points, lines, and surfaces, are identified as sets in

which converge nested things. This method is called «extensive abstraction». Thus, the causal efficacy is in the scope of the whole thing, which is progressively more rarefied at the outskirts[68]. Boundaries do not really exist but they are an abstraction.

- Extended simples: a third way may be to identify boundaries as mereological sums of extended simples, i.e. partless things located in complex regions at the very border of the bounded thing. In that way, it is possible to follow common sense in saying that the thing has boundaries without the controversial thesis according to which boundaries are lower-dimensional.

I endorse the third way. The boundary of a thing, I maintain, is the mereological fusion of extended simples, *pace* Zimmerman (1996, 1996a).

So far, I employ a very basic notion of simple as a proper partless thing. As Markosian (1998b) noted, we need to know also the occasions in which such situations hold, namely under what circumstances a thing lacks proper parts. Markosian raised the simple question about physical objects (SQPO), namely, he asked whether there are necessary and jointly sufficient conditions for a physical object's being a simple. Compare it with special composition question (SCQ) that asks whether there are necessary and jointly sufficient conditions for a physical object's being composite. As with the answers to SCQ, the answers to SQPO must be informative and non-circular or trivial, i.e. they must not employ any mereological term.

[68] For a similar twofold distinction see Stroll 1988: 39-69.

The possible answers may be assembled in four sets: 1. Spatial accounts: these accounts provide an answer based on spatial properties; 2. Fundamentality accounts: these accounts claim that being simple is a fundamental property; 3. Brutal accounts: answers to SQPO recall something philosophically brutal; 4. Indivisibility accounts: according to which to be a simple is to be indivisible.

I advocate as an answer to SQPO the Metaphysically Indivisible View of Simples (MIVS), namely, that a physical object is a simple iff it is metaphysically impossible to divide it, i.e. there does not exist any possible world in which it is possible to split off such object.

First of all, let me briefly sum up the competitor accounts of MIVS just to reject each of them.

1. Spatial Accounts:

1.1 The Pointy View: «Necessarily, x is a simple iff x is a point-sized object». The Pointy View was already abundantly discussed in the literature[69] and I find the main reasons to reject it pretty compelling. In particular, I feel particularly uncomfortable about the left-hand side of the biconditional: only point-sized things are simples. It seems to me arbitrary and it rules out of the domain of possibility many possible worlds inhabited by only one simple material thing such as cubes or spheres[70].

1.2 The Maximally Continuous View: «Necessarily, x is a simple iff x is a maximally connected object».

[69] See, inter alia, Markosian 1998b, McDaniel 2007, and Tognazzini 2006.
[70] An equivalent doubt was already raised by Markosian 1998.

That view has been defended by Markosian (1998b), who defines a maximally connected object as an x that is spatially continuous, i.e. that does not occupy two disconnected regions, and there is no connected region of space, r, such that (i) the region occupied by x is a proper subregion of r, and (ii) every point in r falls within some object or other[71]. The main problem with that view is that it just postpones the problem: what are the necessary and jointly sufficient conditions for a region being connected? Obviously, the answer may not employ any topological term. Markosian does not give an answer to that question and thus his view is unsatisfactory[72].

1.3 The Smallest View: «Necessarily, x is a simple iff x exactly occupies (one of) the smallest region(s) of space».

That view was presented by Tognazzini (2006), just to discard it. The problem is self-evident: it is absolutely metaphysically arbitrarily since it does not give any sufficient reason to hold that a certain specific size is a guarantee of simplicity. A correlated question is in order: how big does a simple have to be?

1.4 The Simplace View: «Necessarily, x is a simple iff x exactly occupies a simplace».

That view is the view defended by Tognazzini (2006), who argues that a thing is a simple iff its region is also a simple. Here we have once again the problem that we have met with the Maximally Connected Simple View defended by Markosian, namely, the problem of answering the

[71] Markosian employs the term «continuous» instead of «connected» and «subset» instead of «subregion». I here show his view employing the term I explain in chapter 1. This version here stated has to be considered as equivalent to the original one.
[72] The definition he gave of connectedness and the other topological terms are axioms and thus his version of the problem may at the most be seen as a brutal answer to SQPO.

question of whether there are necessary and jointly sufficient conditions for a region being a simple. Tognazzini just moves the problem from the domain of things to the domain of regions.

2. Fundamentality Accounts:

2.1 The Instance of a Fundamental Property View: «Necessarily, x is a simple iff x instantiates a perfectly natural property».

That view was presented by McDaniel (2007), just to deny it. McDaniel employs the word «natural» in Lewisian sense (1983). The argument against it raised by McDaniel is long and demands many assumptions, so I invite the reader to take into consideration his nice paper. However, it seems to me that there is also another easier way to debunk that view. Many properties are natural: charge, mass, and so forth. Simplicity appears to belong to that family too. But such an answer, even if true, is circular. Consider the following argument. If x is a simple, then it instantiates the natural properties associated with being a simple. A perfectly natural property seems to be proper partless otherwise it would not be perfectly natural but derivatively so as a mereological sum of other properties. Therefore, we need a notion of simple in order to define «perfectly natural property».

2.2 The Independence View: «Necessarily, x is a simple iff x is the only material object that exists».

Even that view has been proposed by McDaniel (2007). It states that a thing is a simple iff it inhabits an empty world. It seems, as McDaniel stresses, a sufficient reason to be a simple but not a necessary one. In fact, it rules out the possibility that there may be simples in a more populated world.

3. Brutal Accounts:

3.1 The Brutal View of Facts about Simplicity: «Necessarily, x is a simple iff x is brutally a simple.»

That view account for the primitiveness of being a simple: a thing is a simple and that is a primitive fact. I clearly have not much to say about that, since it merely asserts, without explanation, that being a simple is a fact.

3.2 The Brutal View of Answers about Simplicity: «There is no informative, non-circular, non-trivial answer to SQPO.»

That view is the one endorsed by McDaniel. The only way to show that it fails is to propose an alternative, compelling, informative and non-trivial view.

4. Indivisibility Accounts:

4.1 The Physically Indivisible View: «Necessarily, x is a simple iff it is not physically possible to divide x.»

That view was first formulated by Markosian 1998 just to reject it. As Markosian shows, it is easy to find many counterexamples to it: a chain made of an indivisible material, a bomb made of many heterogeneous pieces and so forth. Every of them has parts yet is not divisible.

4.2 The Metaphysically Indivisible View: « Necessarily, x is a simple iff it is not metaphysically possible to divide x.»

The account states that a thing is a simple iff it is metaphysically impossible to divide it, i.e. there does not exist any possible world in

which it is possible split off such thing. That is the view I endorse and so let me give more details about it and let me defend it from its critics.

2.4.1 The Metaphysically Indivisible View of Simples.

According to the metaphysically indivisible view of simples, henceforth MIVS, a thing is a simple iff there is no possible world in which it is divisible.

There are two aspects of the definition that must be looked at in a greater depth:

- the question of divisibility: what is it for a thing to be divisible.

- the question of metaphysical instantiation: what is for an object to metaphysically instantiate a property.

2.4.1.1 Divisibility.

A thing is divisible if it is possible to get more than one new thing from an old one. That is, a thing is divisible when there is an operation of division that brings into being new things from just one thing and such new things' regions taken together are coincident with the region of the old thing. An Ikea's table is divisible since it can be disassembled. However, having proper parts is just a sufficient condition for being divisible. Consider a chunk of cheddar: it has not proper parts as the Ikea's table yet it is divisible into few pieces.

According to the fundamental location relation, a thing is located in a region iff it has the same shape, size and topological relation of that region. E.g., a square is located in a square region and if that square

region is connected with a round region then the square is connected to the host of the round region. There is a sort of harmony or mirroring between the region and its host. Let us call such harmony «location harmony». With that concept divisibility can be understood as follow:

Divisibility: An object x is divisible iff it is possible that the region filled by x, was filled by more than one thing $y_1,..,y_n$ that taken together respect the same instantiation of location harmony as x.

It means that, a thing shaped as a square and of area n^2 is located in a certain region is divisible if it is possible that its region may be filled by several things that taken jointly can turn into a thing shaped as the original one. A point cannot be divisible since its location cannot be occupied by more than one thing. Unfortunately, this characterization is useful just for those who want to rule out extended simples.

Another way to understand divisibility is to assume it as primitive and via such a notion define indivisibility. The formalization is trivial.

Assuming divisibility as primitive has great advantages: it permits more than one way to divide a thing, it does not posit any mereological assumptions, it does not makes assumptions about the structure of space, e.g. gunky, atomistic, and so forth.

Once we have assumed divisibility as primitive, we hence can define indivisibility as its negation.

2.4.1.2 Metaphysical Instantiation.

There are some properties that are instantiated due to the physical laws of a world. Whereas there are other properties that do not depend on any of the physical laws of that world. For instance, being blue

depends on the certain refraction of the light and thus on a certain physical law: my pullover is blue but it would have been red if the physical laws had been different. But consider the property of being human. It seems that that property also depends on the physical laws of the world: if the physical laws of the world had been different, then I wouldn't have been an human being. However, it also seems true that such a world is impossible: if the physical laws were so different that I could not be an human being, then in that so different world there is nothing that is my counterpart. And if there is something that is my counterpart then that thing is such and such regardless of the physical laws of that world. That is, the existence of that human being, no matter how different from me, is not dependent on the physical laws of that world. Then, a metaphysical property may be defined as a property that does not depend upon physical laws of a world: I would have been a human being even if all of the laws of this world had been different. Clearly, in a possible world with a greater atmospheric pressure than our world, the human structure would be different but nevertheless being human *per se* does not depend on that change.

It is worth noting that "not dependent on" does not mean "in contradiction with". It means that "given the set of the physical laws in a given world, a metaphysical property does not depend upon those physical laws". Better: Let the set L be the non- empty set of all the physical laws in a world W at t_1 and let L_1 be a non -empty set of some possible very different physical laws. Let f be a bijective function from L to L_1. At t_2 God decides to replace each member of L with a member of L_1. So, the world W changes in a very deep sense. But, MP still holds even at t_2. This is because a metaphysical property does not depend on the physical laws of a given world.

2.4.1.3 Reply to its Critics.

MIVS must face two objections. The first is the changing properties objection (CPO), raised by Markosian, the second is the trivial answer objection (TAO), raised by McDaniel (2007).

CPO, as stated by Markosian, says that if x, according to MIVS, is a simple then it is not possible for x to change its shape and size in order to become extended and then get divided. His argument may be reconstructed as follows:

1. Let us assume MIVS.
2. Let x be a pointy object.
3. x can change its properties and then get divided.
4. ∴ Thus, nothing can count as a simple, according to MIVS.

I argue that CPO is an objection only to a *de re* reading of MIVS, while a *de dicto* reading either makes CPO unsound or makes MIVS compatible with it.

Let x be a simple, according to the *de dicto* reading of MIVS, it is metaphysically impossible to divide it in any possible world in which x is a simple. Yet it does not entail that x necessarily being a simple in any possible world. But if x is a simple, then necessarily, it is indivisible in any possible world in which x is a simple. Thus, under the *de dicto* reading of MIVS, CPO is either unsound, the premise which claims that x cannot change its properties under MIVS is false, or it is inoffensive to MIVS, because it has just a *de re* statement of MIVS as its target.

Markosian accepted that a MIVS object can exist, but he argued that it can be just a pointy object, while a simple might be extended. Nonetheless, I argue that even an extended simple might be

metaphysically indivisible under a *de dicto* reading. In fact, we can advocate some sort of metaphysically fundamental property that makes such an object indivisible. Yet, of course, in virtue of the *de dicto* reading this object can change or lose this property and get divided in the same way in which a person can lose the property of being immune to a particular illness.

Suppose as analogy the case in which x is the daughter of y and she travels back in time. Necessarily, x cannot kill her father. Indeed, necessarily, x is a daughter iff she has a father. Necessarily, she is a daughter in every world where she has a father. There is no one inevitable force operative in each case. If so, there exists a set of possible worlds where x does not have a father and where she is not a daughter.

In a very similar way, necessarily, x is a simple iff it is indivisible. Necessarily, x is a simple in every world where it is indivisible. There is no one inevitable force operative in each case. If so, there exists a set of possible worlds where x is divisible and so not a simple. Nevertheless, x is a simple in the very same way in which one is daughter.

Let me now turn to the objections raised by McDaniel (2007). Quoting his words:

« My [...]worry about the Indivisibility accounts is that they appear to violate the non-circularity condition on being an answer to the Simple Question, and hence, even if true, will not be competitors to the Brutal View. It seems that the concept of divisibility cannot be explicated without appealing to mereological concepts in the explication (2007:255)».

He argues that it is not possible to give any account of divisibility that does not employ mereological terms. What I claim instead is that

mereological terms are not needed for any account of divisibility. Although I assumed divisibility as primitive, it is possible to give content to «divisibility» without using mereological terms as parts of the definition.

The operation of division can be defined as the operation that holds into being new things from just one thing and that such new things' regions, taken together, are coincident with the region of the old thing. Contrary to this statement, it would be possible to divide a thing without holding into being new things greater in number than the old one not yet divided. It is an odd way to understand «divisibility». Therefore, it is perfectly possible to give a definition of divisibility that does not employ any mereological terms.

2.4.2 Simples and Bulk.

As I noted at the beginning of paragraph 2.4, there are at least three ways to solve the problem of bulk. Let me mention them again: accepting lower dimensional things; considering boundaries as abstractions; positing simples.

I reject the second option since it rules out the existence of boundaries. Indeed, it explains them as sets of thin layers and, thus, as abstractions. And as Simons (1991) says, even if he accepts that sets may be scratched, he cannot accept that one may sit down on sets. I find his *boutade* compelling enough. Moreover, if one believes that boundaries have to be causally efficacious in space-time, then one has to reject the abstraction view since sets are by definition not causally relevant, at least in space-time.

I claim that positing simples, adopting the metaphysically indivisible view, is the conclusion of an inference to the best explanation. What we

have to explain is the causality of boundaries, namely how it is possible for such things to be causally relevant and yet in some sense lower dimensional. Let me state the argument and then justify its premises.

If boundaries exist, then they are (a) lower dimensional and (b) causally efficacious. Assume the antecedent. The best way to make the conjunction in the consequent true is to posit simples.

As I mentioned, "lower dimensional" may have two different although mutually consistent explanations: (i) "lower dimensional" may mean having one dimension fewer than the bounded thing; (ii) "lower dimensional" may mean lacking proper parts.

The two meanings of lower dimensional are not inconsistent albeit not mutually entailed. A thing may be two dimensional and lack proper parts. A thing may lack proper parts but that does not make it two-, or one-, or zero-dimensional. Clearly, a thing may be three-dimensional and nevertheless lack proper parts.

The first definition of lower dimensional things has some problems with (b). It is easy to see that a two dimensional surface may be scratched. But it is difficult to imagine how it can ward off a ball. Suppose you throw a punch at a surface of a wall with all your might. Unless you are Achilles, you should get hurt. How is it possible? How can a two-dimensional surface, something that lacks bulk and then mass and volume do this? Perhaps it is possible, but it is at odds with our intuitions. The best way to explain the pain you suffer after throwing a punch at the wall is to posit that its boundaries are three dimensional as is the wall itself. Perhaps a dense skin of three dimensional simple: an outermost wrapper made of simples. Surely, in that way you should give a better

explanation to your pain and, more in general, of the causal activity of boundaries.

2.5 On the Number of the Boundaries.

Part B2 of the definition of "boundary" states that a boundary is the part of a thing whose task is to divide it from its complement. Put in other terms: every thing that is part of x is on one side of the boundary and every thing that is not part of x is on the other side. For instance, every region of Sardinia is on one side of its border and every region that does not belong to Sardinia is on the other side.

That definition entails that every thing has no more than one boundary: suppose a thing has two boundaries; in that case one of the two boundaries has to be part of the complement of the thing. Suppose Sardinia has two discrete borders, since they are discrete the regions they bound are also discrete and hence those regions are mutually the complement of the other. Which one belongs to Sardinia? Both, since Sardinia has two discrete boundaries. Therefore, Sardinia is composed both of its regions and its complement. It is absurd.

Clearly, Sardinia has just one continuous border. In the same way, a sphere also has just one boundary: its surface. But what about a dice? It seems it has six surfaces, one for each of its edges. From that, Stroll (1987) infers that a dice has six surfaces and thus six boundaries.

I think that his argument is unsound, since one of its premises is false. Let me state a more formal reconstruction of the argument and then argue against it.

1. x and z are two of the faces of a given dice and y one of its edges that overlap both x and y. (assumption)

2. x is a boundary of y iff x demarcates y from its surrounding (B2)

3. y divides x from z (from 1 and 2)

4. x is different from z (from 3 and Leibniz's Law).

5. The dice has more than one boundary (from 1 and 5).

I think the premise 3 is unsound and thus x and z are not different, in a sense I am going to outline.

There is an obvious sense in which the argument is true: where there is a discontinuity there is a new thing, as B2 states, and, since y is a discontinuity, x and z are different. Nevertheless, it entails that the dice does not exist, but rather there are just "its" faces since each of them is separated by the other by an edge. If we want defend the existence of the dice, then we need a way to invalidate 3 and show that an edge is not a genuine discontinuity. I guess there are two strategies.

According to the first strategy, it is meaningless to speak of a genuine discontinuity since the edge between x and y is not a discontinuity but a common part of the two faces and, hence, they overlap. Suppose you can spread the dice as a complete layer: in that case, the edge turns into a part of an otherwise uniform layer, the area of which is the sum of the area of the previous faces. Suppose you have to calculate the area of x and z: if one detaches z from the dice the areas of both x and z change and then one is allowed to think that the edge was part of both of them. Therefore, the edge is part of x and z and then a dice has just one boundary.

According to the second strategy, the argument begs the question. Indeed, 3 assumes the existence of an edge from the single fact that the edge has a name and that name has certain features. But there is no fact of the matter that guarantees the existence of an edge as an autonomous thing. Suppose you have to detach it. According to the features dictated

by the identity conditions of the name, an edge is a line and thus something without bulk. Since it has no bulk it is in principle impossible to detach it since once it is detached it cannot occupy space, unless one assumes the very controversial thesis according to which space can host things without volume, as for instance Hudson (2005) is willing to do.

2.6 Objects Depend Upon their Boundaries.

According to the mainstream view, boundaries depend upon the objects they bound[73] (e.g., Chisholm:1983; Correia 2008: 1015; Casati and Varzi: 96; Smith 1996: 295; Sorensen 1998: 275; Varzi 2007: 995). In what follows I argue for the converse, namely objects depend upon their boundaries.

In order to do that, I need a metaphysical machinery, namely a more formal regimentation of the notion of dependence. I shall outline the main reasons of those who claim that boundaries depend on the objects they bound and finally I shall argue for my own view.

2.6.1 The Various Kinds of Ontological Dependence.

I depend on (i) my university and also on (ii) the human species. I also depend on (iii) my girlfriend and on (iv) certain physical laws that allow life on earth.

There are many kinds of dependence. I'm here interested only in cases similar to (ii) and (iv), namely the so-called ontological dependence: x depends on y iff x exists only if y exists.

[73] As I said in the introduction, here I employ the term "thing" to refer to every spatiotemporal entity that is not a region. Whereas I adopt the term "object" in a narrower sense, just to refer to every spatiotemporal entity that is not a region and not a boundary and not an event, e.g. tables, cats, tree, stones.

There are many ways to characterize ontological dependence[74], here we need only two:

Rigid Ontological Dependence: x rigidly depends on y, namely x cannot exist unless y does. That is, x depends on a specific thing y. For instance, the set of rational numbers specifically depends on rational numbers.

Formally,

$\Box(Ex \rightarrow Ey)$[75]

Generic Ontological Dependence: x generically depends on something P, namely x cannot exist unless something with the property P does. That is, x depends on whatever thing has the property P. For instance, red things generically depend on redness.

Formally,

$\Box(Ex \rightarrow \exists yFy)$

The two notions of dependence can be read as notions of necessitation, namely as the converse. These are usually called Rigid Ontological Necessitation, when x rigidly necessitates y and generic ontological necessitation when x generically necessitates y.

We need two more notions: ontologically dependent things and ontologically independent things. That is, the answer to the question that asks what are the necessary and jointly sufficient condition for a thing's being independent. As it turns out, an ontologically independent thing is the one that can exist even though no other thing had never existed. Whereas an ontologically dependent thing is one that cannot exist in that situation. In a more rigorous form:

[74] For a complete survey see Correia 2010 and Lowe and Tahko 2016.
[75] You can find the same formalism in both Fine 1995 and Correia 2010.

Weak Ontologically Independent Thing: x is ontologically independent iff for every y, y is different from x, there is a possible world in which x exists and y has never existed.

Strong Ontologically Independent Thing: x is ontologically independent iff for every y, y is different from x, in every possible world x exists and y has never existed[76].

Both definitions can be used in order to regiment the notion of ontologically dependent things in a straightforward manner. It is equally clear that both can be specified under one kind of ontological dependence, i.e. either rigid or general. Moreover, both can be narrowed to specific independence cases: for instance, a fish is weak independent to the water, that is there is a possible world in which that fish is alive regardless of the water.

2.6.2 The Mainstream View: Boundaries as Dependent Things.

According to the more widespread view with very venerable roots in Aristotle and Brentano (Smith 1997) boundaries ontologically depend on bounded objects. There are two ways in which a boundary can depend on a bounded object, as I said above:

Boundaries rigidly dependent on the bounded object (Correia 2010)

[76] The two can be seen as the converses of supervenience.

Boundaries generically dependent on the bounded object (Varzi 2007; Smith 1997; Chisholm 1983, 1989, 1994)

I drop here the first possibility due to its implausibility and the fact that Correia neither argues for it nor outlines its conditions, but just mentions it.

Let me expose the second possibility. Two conditions must be satisfied in order for a boundary to depend on its bounded object, according to all the quoted philosophers: 1. The bounded object is not a boundary of a further thing; 2. The bounded object is one dimension greater than the boundary.

For instance, a surface must depend on a three dimensional object. The underlying moral is that a lower dimensional thing cannot exist unless it bounds a greater dimensional whole[77].

I do not find either of the two clauses completely compelling. Assume for the sake of argument not my definition of lower dimension but instead the classical one, in order to not upset the philosophy of those who believe in boundaries as dependent things.

Let us begin with the first clause. Consider a dice and one of its faces. That face is part of the boundary of the dice. Consider that face, arguably it has a boundary, namely its edges. Consider that edges, they also have a boundary, namely points. Thus, a boundary can belong to another boundary.

Let us consider the second clause. It says that the boundary has to have one dimension fewer that the bounded thing. Come back to the dice.

[77] There is also a semantic motivation to it, as Sorensen 1998:287 argues. Perhaps, a boundary may also exist without the bounded object. But in that case it is meaningless to label it a boundary, since there is nothing it bounds. Fair enough. But that thing that was a boundary seems to survive even if it does not bound an object. Hence, perhaps a boundary semantically depends on the bounded object but not ontologically.

Consider once again one of its surfaces and now one of the points of which that surface consists. Is it part of the boundary of the dice? It seems that the answer has to be affirmative, as Hudson (2005: 70) also remarks. Thus, a boundary does not have to have only one dimension fewer than the bounded object.

2.6.3 Objects and their Boundaries.

As I sketched in the very beginning of the paragraph, I claim that objects depend upon their boundaries. I first have to prove that a boundary can exist without bounded thing and, second, that a bounded thing cannot exist without boundaries.

I argue for independence by demonstrating that we should accept the conjunction of the two following doctrines:

Liberal view of receptacles (LVR): every region of space possibly hosts a thing.

Doctrine of splitting (DS): if x is a proper part of y then y can be detached from x with a remainder.

Indeed, LVR and DS jointly entail the possibility of detached boundaries: LVR says that size and shape do not matter for being an independent thing[78]. DS says that every complex thing can be dissected[79].

[78] See also Hudson 2005: 47-56. For criticism Cartwright 1975.
[79] DS is a trivial theorem of any mereology that includes proper parthood as a strict partial order and weak supplementation.

Thus, boundaries no matter how they are, may also exist without bounded objects[80].

In a more rigorous fashion:

1. LVR (assumption)
2. DS (assumption)
3. x is a boundary of y (assumption)
4. x occupies a region (from 1 and 3)
5. x can be detached from y (from 2 and 3)
6. x does not depend on y (from 4 and 5)

It entails that boundaries are weak independent things. Indeed, it can exist at least a world where x does not necessitate y.

Those who are not friends of DS can replace it with another more moderate principle of splitting: for instance a principle that admits that it can be extract from a thing just its outermost parts and not its interior.

Under the closure of my non- standard definition of lower dimensionality LVR can also be replaced with a more moderate principle that bans points, lines, and surfaces.

On the basis of the justified assumption that boundaries are extended simples, we can therefore accept them as independent of the bounded object. However, the converse does not hold: there are no objects without boundaries. In other terms: objects depend upon their boundaries.

I fulfill the task showing that it is impossible to pick out objects from reality if there are no boundaries that divide them from their surroundings. The outcome is that it is impossible to count an object as

[80] A similar argument was employed also by Hudson (2005: 70-71) without specifying the assumptions.

an unit of an ontology, where there are no boundaries. That is, a Quinean ontology needs boundaries: counting non- mutually discrete units is impossible since it is impossible to determine how may units there are.

Let us begin with the intuition according to which boundaries fix both composition conditions of an object and persistence conditions:

- composition: how many parts can an object count? Every thing that is inside the boundary is a part of that object whereas every thing that is beyond the boundary is not.

- persistence: how can an object survive changes? Assume your preferred ontology of time. Consider now a thing with a finite career, e.g. a human being, a table, a stone. If these things were temporally boundaryless then it would be virtually impossible to establish when they start and when they end their careers. It would be also impossible to determine how they change in shape, since boundaries determine the shape of an object. Thus, all talk about persistence would turn out meaningless.

In other terms, speaking about something spread in space and time without boundaries is meaningless unless we are speaking of the universe within an eternalist framework[81].

Nevertheless, our universe is also divided into discrete objects or things. In general, every continuous spatial field can be divided by means of boundaries. Consider a piece of red cloth. If you have a look at it you count it as a single unit without any parts. Now, suppose that a tailor draws five circles on it with white chalk. You can meaningful say that there are 5 circles on the red cloth. It is possible since the white

[81] I think that even in a tenseless context of utterance boundaries are necessary in order to individuate things or objects in time. However, this point is beyond the aim the dissertation.

boundaries make a difference from the interior of the circle to the exterior.

Nevertheless, it seems that an object is a more complex thing than a circle: it has certain sortal properties that dictate its composition and persistence conditions. And boundaries are exactly where those properties are instantiated. They thus depend on such properties. Better, sortals determine boundaries. What are sortal properties? As Bennet 2009a and Sidelle 2016 point out the intersection of modal properties and persistence conditions are what are called sortal properties, namely the properties that establish what a thing is: under what conditions it survives, and which changes it can undergo without losing its identity across time and worlds. If a certain portion of reality has a consistent conjunction of modal properties and persistence conditions, it belongs to a certain sortal or kind. In other words: when you bump into such a conjunction of properties, then if they are internally consistent, you find a certain thing.

In a more elegant version: to every consistent set of modal properties and persistence conditions instantiated by the material content of a certain region corresponds a sortal, whose essential properties are the ones collected in the set. Why is it that only modal properties and persistence conditions are sortal?

Assume that modal properties are those properties that ensure the surviving of an entity, or of its counterpart, across possible worlds. Persistence conditions ensure the surviving of an entity across time. Consider a tree: it seems that other properties also define its membership in the set of trees: consistence, texture, atomic structure and so forth. But only the modal and persistence formulation of such properties are sortal, for they define what must be identical across worlds and time in order to preserve the identity conditions of such a

thing. Consider, say, the non- modal property P of an x of sortal S. If x loses P, since P is not necessary, x does not lose its membership in sortal S and nothing significant for the surviving of x happens. Suppose now that x loses the property of being necessarily P for belonging to the sortal S. Since P is necessary for x in order to be what it is, namely a member of S, x is not what it was before losing P, anymore. Therefore, since membership in a sortal is a function of modal properties, only the modal instantiation of a property may be a sortal one.

Once the definition of sortal is fixed, it is necessary to understand how many sortals there are. In order to avoid metaphysical arbitrariness, I assume that there is a sortal for every consistent conjunction of modal properties and persistence conditions[82].

An object is, by definition, something discrete from its surrounding and its neighbors. In other terms, an object is an individual: something that can be counted as one and that can be distinguished from its surrounding. I claim that boundaries carry out that individuality[83].

Consider the well-known example proposed by Wiggins (1968): tree and cellulose are different insofar as they belong to two different sortals. And they belong to their sortals for they have the needed properties. If those properties are rightly aggregate, then there arises a thing of a certain sort. The space where such properties are instantiated is full of things. Maybe not completely full, however, full enough. Consider the content of the region of tree/stuff and consider the content of the region beside. Both have their content and their content instantiates some properties. Consider what it would mean for both to be boundaryless: how would it be possible to distinguish which properties belonged to the first thing and which one to the second entity?

[82] This position was already argued by Bennet 2009a and Hirsh 2011.
[83] See also Varzi 2011: 9. For an alternative view see Clarke 1981.

Answers may be: 1. they instantiate different sortals whose properties are already fixed. You just need to find where the properties of the considered sortal are and there is the thing you are looking for; 2. Where there is a contradiction among sortal properties, there is a new thing. In both cases you do not need boundaries.

Unfortunately, both answers are unsatisfactory: 1. There is a sortal for every consistent conjunction of modal properties and persistence conditions for avoiding metaphysical arbitrariness, then without boundaries it is impossible to stop the conjunction. It is thus impossible to discern the two things when they are boundaryless; 2. Suppose that two tables lie one beside the other. In the two regions where such tables are located there is a continuous instantiation of consistent sortal properties. If the two tables were boundaryless then there would be no way to distinguish one from the other, unless boundaries existed. Thus, inconsistency cannot be a correct way to individuate an object.

If every attempt to individuate boundaryless things is either inconsistent or incoherent, then, things necessitate boundaries.

What kind of necessitation is there instantiated? I guess it is the rigid one, since a thing necessitates precisely the boundaries it has for they exactly determine its composition and its persistence across time. Different boundaries determine different composition, for instance one part less.

2.6.4 From Boundaries to Objects: A Model.

Boundaries carve nature at its joints. Better: boundaries are the natural joints, namely, they identify the natural demarcation in nature and dissect it in natural units, i.e. objects.

How do boundaries carve nature? In other terms: how do boundaries pick objects out from nature?

I claim that we can represent boundaries as one-to-one functions from regions to objects[84,85]. Let me explain how the formal machinery works.

Let R be the set of all possible regions in a world @. For each r ∈ R when o is located in r there is a one-to-one function b from r to o. The function b is the boundary of o in r.

$$b(r)=o$$

When r is an empty region, i.e. a region without material content, the value of the function is 0.

A boundary function can collect as arguments an ordered set of regions when the object occupies a fusion or a set of non -connected regions:

$$b(r_1,\ldots,r_n)=o$$

From the definition of function can be deduced that every object has a different boundary. Consider the material content of a region, with all its physical properties, in order to find also its metaphysical properties, such as persistence conditions and composition criteria, you have to individuate its boundaries. Once you find them, you also find the object located in that region.

[84] I work under the substativalist assumption according to which objects and regions are not mutually reducible. Yet the model also goes with the supersubstavalist assumption, i.e. the doctrine according to which objects are literally identical to their region.

[85] For similar models see Einheuser 2011 and Fine 2008.

3. Things Cannot Keep in Touch.

"Noli me tangere."

Giovanni 20,17

Consider two things next to each other. For instance: two dices Blully and Reddy. Assume that they are discrete and that nothing lies between them. According to common sense, we can say that they are in contact or they are touching each other. That is, the westernmost part of Reddy is touched by and touches the easternmost part of Blully and so the converse. As I stressed, the outermost part of a thing is its boundary, hence two things touch each other iff their boundaries do.

We often run into cases of contact in our everyday life: when we put our hand on a desk; when we move the desk against the wall and so forth. Moreover, contact has very interesting implications in mathematics (Smith 2007), metaphysics of space (Varzi 1997, 2011b, 2015; Hudson 2001, 2005; Kilborn 2007; Cotnoir and Weber 2015) and even in artificial intelligence (Vieu 1997), since contact is one of the main notions of spatial reasoning: moving around in space demands an ability to avoid obstacles and clearly avoiding them entails avoiding the contact

with them. Contact is crucial for those who are interested in territorial studies.

Nevertheless, contact gives rise to a famous paradox strictly related to Zeno's[86]. In what follows I show that each of the solutions so far proposed in the literature fails to solve the paradox either because they are inadequate or because they give rise to even more controversial problems.

In the first part of the chapter, I give a more detailed definition of contact; in the second part I state the paradox and show why every solution is highly controversial.

3.1 The Notion of Contact.

There are many possible ways to characterize the notion of contact. Let us begin with the commonsense notion and then let us formalize it within the mereotopological framework.

When we employ the notion of contact we would like to say that two things are as close as possible without sharing parts, i.e. nothing divides them. In other words: their boundaries are attached but discrete. Hence, we can say:

T1: Two things are in contact iff there is nothing between their boundaries.

That characterization suffers from a problem, that is, it admits a case in which two things are separated by a non-zero distance and nevertheless there is nothing in the region between them: suppose a

[86] Discussing the relation between the two paradoxes is beyond the scope of the dissertation. See Hawthorne (2000).

world that is otherwise empty world except for two dices, Reddy and Blully. Reddy is located in r_1 and Blully in r_3. The two regions are not connected since there is a further region r_2 between them. Since the world is empty except for the two dices, there is nothing between them and nevertheless, they are not in contact. We need a different characterization that avoid this counterexample, without employing a metric, as I assumed to minimize the ideological commitment of the theory. One way out might be to say that the emptiness of the region between the two is a matter of necessity.

Strong-T1: Necessarily, two things are in contact iff there is nothing between them.

But this is not enough. This statement states that two things are in contact when it is impossible that the region between them was occupied. Unfortunately, there is a counterexample. Suppose there is a special force that keeps them apart. In a case like that, it is possible that two things may not be in contact while, nevertheless, nothing lies between them due to that force. The force keeps the two things apart and guarantee that nothing is located in the regions between them. They then may be distant and, thus, not in contact. What we mean with the notion of contact is rather that the two touching things are located in two adjacent regions and, nonetheless, they do not share any part.

T: Necessarily, two things are in contact iff the region of the first shares its boundary with the region of the second and yet the two things are mutually discrete.

I think that T mirrors our ordinary concept of contact: two things are in contact when their boundaries are attached and, nevertheless, the two things are discrete[87,88]. Consider again the two dices, Reddy and Blully: two of their faces are attached and yet discrete when the region of Reddy is as close as possible to the region of Blully. The limiting case of closeness is clearly overlap. Contact only requires that the boundary parts of the two regions overlap: the boundary part of the first region is shared by the second region. Otherwise, either there would be something between them or there could be something between them.

I formalize the notion in the following fashion:

$$Txy =_{df.} \Box\forall x\forall y\forall r_1\forall r_2(Lxr_1 \wedge Lxr_2) \wedge (OBr_1r_2 \wedge Dxy)$$

Let OB be the operator boundary overlap:

$$OBxy =_{df.} (Bwx \wedge Bzy) \wedge Owz$$

The formalization states that two things are in contact when the boundaries of the regions of such things overlap and nevertheless the two things do not. That characterization is the source of a well-known paradox.

3.2 The Paradox of Contact.

Let us assume T as the formalization of our commonsense notion of contact. Now consider once again Reddy and Blully: two discrete dices of

[87] The account is equivalent to the one proposed by Hudson 2001:126, Hudson 2005: 65 and Chisholm 1975.
[88] The account may be clearly stated without any modal strength.

volume v^3 made of stuff m. Consider the westernmost face of Reddy and the easternmost face of Blully, namely their respective east and west boundaries. According to T, they are in contact when the boundaries of the regions in which they are located overlap. In that case, either the boundaries of Reddy and Blully overlap or there is a further region between them.

The first disjunct entails co-location, i.e. two discrete things share the same region. Co-location is perhaps possible but not actual since according to the physical laws of our world two discrete quantities of stuff cannot be located in the same region (Zimmerman 1996; Sider 2001). In that case the account I gave cannot be necessary and, thus, cannot represent the contact in our world according to our commonsense, which was what we looked for.

The second disjunct denies my notion of contact and entails that even two touching things have to be separated by a region. In that case, they are not in contact since they are not as close as possible insofar as there is a region between them. Moreover, according to LVR, that region may be filled for it states that every region of space is the possible host of a thing. However, if we deny LVR the problem also goes on: there is an empty region between the two and so the two are not as close as possible[89].

In a more rigorous way, the paradox can be stated as follows:

1. x is located at r_1 and y is located at r_2. (assumption).
2. x and y are in contact in the way stated by T (assumption).
3. Either (3.1) x and y share their boundaries or (3.2) they do not

[89] For an history of the paradox and a list of historical solutions see Zimmerman 1996. The first to discuss it was Peirce (1933). Indeed, it is often called Peirce's Paradox. In recent years, the problem was again faced by Chisholm (1981) and even more recently by Varzi (2004).

(from 1 and 2).

Following the first of the disjuncts of 3:

3.1.1 x and y overlap (contradiction)
3.1.2 x and y does not overlap
3.1.2.1 x and y has something in between (contradiction)

Following the second of the disjunct of 3:

3.2.1 There is a region between x and y (contradiction).

Either way, we arrive at a contradiction. We then find a way to account for the intuition that two things can touch each other without contradiction.

3.2.1 Constraints to the Solutions.

Let me rule out, then, two of the possible solutions before we go any further. I do not argue directly against them but rather I show how the proposed solutions are as controversial as the contradiction we want to avoid.

The first is a classic solution proposed by Brentano in 1988 and then rediscovered by Chisholm in 1983 and eventually formalized by Smith in 1997.

According to Brentano and his later acolytes, two things are in contact iff their boundaries are co-located. That is, two discrete things can be said to be in contact when the region of the boundary of the first is located in the very same region of the boundary of the second. As noted in § 2.1.2,

that strategy has few undesired consequences. It can lead to the very counterintuitive situation in which two things interpenetrate, unless one dictates a metaphysical status for boundaries as possibly coincident things, as in fact Brentano and his acolytes did. Although, one can hold this position without arbitrariness, one has to claim that there is something in reality that can share its region without sharing parts. Suppose I shake your hand: in that case, the outermost part of my hand, i.e. my skin, would be in the same region of the outermost part of your hand, i.e. your skin. Hence, our skin would be in the same place at the same time despite our not sharing any parts, insofar as we are two different persons. This is very counterintuitive and, I suspect, false. Surely, it does not mirror our commonsense notion of contact. I then rule out the possibility of co-location for two discrete things, at least in the actual world.

The second is the solution proposed by Cotnoir and Weber 2015 who employ formal and metaphysical machinery proposed by Priest in 2006. The solution they proposed is to change the underlying logic of the puzzle. Instead of classical logic, they assume a paraconsistent logic, that admits contradictions. What they state is a glutty account, that is, a boundary is part of both a thing and its complement. Consider Reddy and Blully. According to Cotnoir and Weber they are discrete, yet, nevertheless, their boundaries overlap. Despite their not sharing parts they share their boundary parts which are formalized as empty parts. Such a view is easily conceivable within a paraconsistent framework. The view has an odd consequence, as a theorem, namely, a thing can both have and not have its boundary. That is, things may be both lack a boundary and own a boundary. It is consistent with a paraconsistent logic and it does not give rise to any problems in this framework. Nevertheless, it seems to me that this way of solving the paradox is too

far from our intuitions. Indeed, I think that the paradox is usually thought of as a problem for two ordinary things and, thus, for two things both equipped by boundaries. Furthermore, I have so far employed a first order classical logic and, hence, I would like to use its rules as norms for our metaphysics.

3.3 Contact and the Nature of Space.

The paradox of contact depends only upon the nature of space: things can or cannot touch each other iff the space in which they are located instantiates suitable conditions. I rule out any possible world in which external events keep apart two things. The world I consider upholds the following conditions (Kilborn 2007):

-there is no special separation force, such as repulsion force between discrete things;

- there is no contingent event, such as a third thing accidentally put between the relevant two;

- there is no physical law that bans contact, such as a minimal physical distance between any two discrete things.

I do not assume plenitude of space: space is filled at least by two things that would like to come in contact. Since my definition of contact involves regions I assume here substantivalism, i.e. there are just two kinds of entities: things and regions; nevertheless, I think that all of the following objections to contact may also work well against things in supersubstantival space, i.e. there things are identical to their regions.

In the following sections, I outline the following various kinds of space:

a. dense, i.e. between every two things there is a further one.

b. atomless gunky, i.e. every thing has a proper part.

c. discrete, i.e. two points can be adjacent to each other.

d. non-standard theory, i.e. discrete things in dense space and dense things in discrete space.

I analyze the possibility of contact in a., b., and c., but I do not face d. since it suffers from the same problems as a. and c.

What I eventually maintain is that there are no suitable conditions for our intuitive notion of contact. Surely, it is possible to account for an *ad hoc* notion of contact that involves weird assumptions or that entails strange conclusions. I would like to show that whatever the structure of space would be, it is either impossible to account for the intuitive notion of contact, i.e. it entails a contradiction, or it entails very strange and controversial corollaries.

3.3.1 Contact in a Dense Space.

The paradox seems to appear because the space is dense: there is a further point strictly included between any two points. We can state density in the following manner:

Density: Given any two points x and y, no matter how close they are there is a further point between them.

Point: x is a point iff (i) x is a simple; (ii) x is zero-dimensional.

The assumption of Density tells us that space is isomorphic with the line of the real numbers. It is worth noting that Density entails that between any two points there are infinite points. Density may also be rewritten for those who deny the existence of points and instead accept extended simples.

Simple-Density: Given any two simples x and y, no matter how close they are there is a further simple between them.

Therefore, since there has to be a thing between any two arbitrary given things, when two things are in contact either they overlap, or their boundaries coincide. I immediately reject the second disjunct since it contravenes the assumption that bans coincidence.

The first disjunct tells us that two things are in contact when the boundary between them is part of both[90]. I think that such a view should be rejected since it contravenes one of the clauses of our notion of contact. Nevertheless, consider a different notion of contact that does not involve mereological discreteness. Let the same old two dice Reddy and Blully be in contact. According to that new view, they are in contact iff they share a part, namely one of their faces. It means that one of the faces of one dice when keeping in touch with the face of the other also becomes part of the other dice. Which one? It seems completely arbitrary to choose one or the other[91].

Moreover, consider the two overlapping dice and two other parts for each of them taken arbitrarily: a for Blully and a* for Reddy. Consider the close interval from a to the boundary of Blully: every thing there is within the interval is a proper part of Blully. Consider the close interval from a*

[90] Hawthorne 2000 argues for this view in a slightly different yet equivalent manner.
[91] For this paradox see Casati and Varzi 1999: 86-87.

to the boundary of Reddy; every thing there is within the interval is a proper part of Reddy. The fact that the boundary is part of both entails that a is a part of Reddy and a* is part of Blully[92]: consider the close interval [a, a*]; at a certain point of that there is a boundary. Since the boundary belongs to both Blully and Reddy, there is no distinction between them that says when one ends and the other starts. Consider now that every points in the interval [a, a*] is a proper part of the interval. The interval is a proper part of both Blully and Reddy and then, by the definition of composition, every proper part of the interval is a proper part of both Blully and Reddy. Therefore, a* is part of Blully and a is part of Reddy. By universal generalization, they share all their proper parts. Therefore, again by the definition of composition and extensionality of parthood, they are the very same thing. It is a very controversial outcome: when we claim that two things touch each other we want to say that they are attached and, however, distinct. Within that account, it is impossible to be in contact and yet be distinct[93].

Moreover, there is another reason to reject coincidence as overlap. According to the thesis (iii) about boundaries explained in chapter 2 a thing inherits every operation that its boundary undergoes. Then, contact must be transitive, but overlap is not. Therefore, contact is not overlap.

[92] It is not a problem if one assumes universalism. But in that case speaking of Blully and Reddy turns out to be meaningless.
[93] It also violates the isomorphism between space and real numbers. See § 3.2.1.1

3.3.1.1 Closed and Open Things.

The traditional way to solve the paradox of contact is to assume that things can only touch when one of them is closed and the other is open. In a more rigorous way:

C-O-contact: x and y are in contact iff only one of them owns the boundary between them and there is no unoccupied region between them.

As I formally show at page 49, an open thing is a thing that does not count a boundary among its proper parts, whereas a closed thing is a thing that counts a boundary among its proper parts.

Let me briefly show how that theory works. Consider Reddy and Blully. Reddy owns all of its faces. Whereas Blully lacks them. Suppose Reddy and Blully go through the same cubical path, Reddy from left to right and Blully from right to left. At a certain region, they meet each other. In that region, they can come in touch since there is no further point between them: since Blully lacks the relevant face, the face of Reddy become the boundary of Blully and however such a face does not become a part of Blully. That view is a consequence of the isomorphism between space and real numbers. Consider the line of real numbers and arbitrarily take a number: that number can be owned either by the right side of the line or by the left side of the line, but not by both of them. That is what Putnam (1994) calls "Dedekind Cut Theorem". The consequence of the theorem is that one of the lines is closed, since it owns its last point, i.e. its boundary point, and one is open since it does not own its boundary point.

Picture 3. O-C-contact

I called such a view traditional since it is the one usually accepted within the framework of Kuratowski's axioms of topology and proposed as a notion of contact within the standard characterization of mereotopology (Casati and Varzi 1999; Varzi 2007). It was firstly proposed by Bolzano 1851 and Brentano 1976 famously labelled it as "monstrous doctrine": one of the two things is a monster that lacks its boundary and hence lacks a last part or point.

There are two main reasons for rejecting this view: (i) it does not represent a genuine notion of contact; (ii) it is metaphysically arbitrary.

(i) Consider once again Reddy and Blully. Reddy is a closed thing and Blully an open one. They are in contact iff the last part of Reddy closes Blully. It seems to entail that beyond the last part of Reddy there is the first part of Blully. But it is clearly not so, since Blully is open and thus it lacks a first part. Then: what does exactly Reddy touch? Suppose I move Reddy one step back: since Blully is open it has no last point and therefore no matter how many steps back Reddy makes, it turns out to be always in contact with Blully. It seems to me a wrong picture of contact, since it admits contact even between two not as close as possible things.

(ii) Let us assume the following notion of metaphysical arbitrariness:

Metaphysical Arbitrariness (MA): x is metaphysically arbitrary iff (i) a part of x is human- independent and (ii) any possible explanation of a part of x as F involves extra- logical propositions about x.

The first clause states that an x is metaphysically arbitrary when at least one of its parts belongs to the furniture of reality. The motivation behind the clause is straightforward: if every part of the referent of the proposition is conventional or social constructed, it turns out to be a proposition perhaps arbitrary but not metaphysical. The second clause states that the explanation for the fact that x is an F involves a non-logical proposition, namely some of the facts about x as an F are not inferred from x itself. Those facts about x are thus arbitrary, since they do not originate from x but are dependent on other things, for instance, human aims.

Let us come back to the classification of things in the world as open and closed. Such a division seems not to be metaphysically arbitrary. Consider Reddy and the atmosphere in which it lies: it seems obvious that Reddy owns its boundaries and, hence, is closed. Whereas it seems meaningless to speak of the boundaries of the atmosphere. Since our intuitions are based on how such things are made, they are not arbitrary. The same goes if Reddy was immersed in the water. That is just half of the story. Let us consider an old puzzle traced back to Leonardo da Vinci (1938: 75-76): what is it that divides the atmosphere from water? As I said, they seems to be both open and nevertheless they seem to be in contact. Perhaps one of them is closed. Which one? It seems arbitrary to choose one or the other. At any rate, the choice seems to be based on the need to ask the question not on the things in themselves. Consider a more complex case in which Reddy floats in the water and then some of its parts are immersed and some of its parts are emerged: is it open against one of them and closed against the other[94]? Any choice seems to depend

[94] For an *ad hoc* solution see Brentano 1988. For an introduction of puzzles like these see Morena 2002 and Varzi 2011, 2013.

on the need of asking the question and not on any metaphysically non-arbitrary fact.

3.3.1.2 Contact in Atomless Gunk Space.

A long venerable tradition in the history of philosophy and metaphysics of space denies the existence of points, lines, and surfaces (Brentano 1988; Whitehead 1917[95]). There are, then, no simple things: every thing is complex i.e. it has a proper part[96]. That claim may be formalized in the following way:

Atomless Gunk: $\forall y(Pyx \rightarrow \exists zPPzy)$

Those who hold Atomless Gunk claim that every thing has a proper part and, given weak supplementation, every thing has more than one proper part. Therefore, Atomless Gunk entails that things are infinitely divisible, since no matter how small a thing may be, it has a further proper part[97]. Within this framework boundaries do not exist, either way they are conceived, since there are neither standard lower dimensional things, such as lines, points, and surfaces, nor simples. Therefore, every thing is topologically open, i.e. every thing lacks boundaries among its

[95] Whitehead's metaphysics is about events and not things, but it can be adapted to it in a very easy way. Moreover, such metaphysics when applied to space is usually analyzed as having regions as fundamental things and all other things, e.g. objects, are derivative. That particular is beyond the problem here discussed. I then overturn it and I assume here a Whitehead's metaphysics applied to things broadly understood instead of regions, as also Zimmerman 1996 did.

[96] «Every event contains other events as parts of itself; […] every event is a part of other events; fourthly given any two finite events there are events each of which contains both of them as parts» (Whithead 1920: 50).

[97] As Cotnoir (2013a) argues also an atomistic model, i.e. a model which fundamental parts are simples, can have infinite descending proper parthood chains.

parts. Is there place for the possibility of contact? As Zimmerman (1996) argues, in fact, there is, and he provides the following account:

> Open-Open-C$=_{df}$. x is in contact with y iff there is a line which (a) contains no two-dimensional segments falling entirely outside of regions occupied by either x or y, and (b) contains no point in a region occupied by both x and y (Zimmerman 1996: 15).

That is, x and y are in contact when there is a no more than two-dimensional empty region between them. How is it possible if every lower dimensional thing is banned? According to Whitehead and his acolytes, it is possible to yield lower dimensional things by a method called "extensive abstraction", i.e. lower dimensional things are identified as infinitely converging sets of nested things.

Following Whitehead (1920: 52), let a and b be two things. If a extends over b then a is bigger than b and b is a proper part of a. Moreover, let an "abstractive set" be a set in which (i) given every two members of the set x and y, either x is a proper part of y, or y is a proper part of x and (ii) there is no z that is a proper part of every member of the set, that is, there is no null-element. Using the nice metaphor employed by Whitehead himself, such a set is as a «Chinese Toy which is a nest of boxes, one within the other, with the difference that the toy has a smallest box, while the abstractive class has neither a smallest event nor does it converge to a limiting event which is not a member of the set». There is thus no a minimal thing without dimension. Even though there is no a smallest thing such as a point, things may be ordered by dimension: from the biggest one to an arbitrary smallest limit, to which the biggest converge. The smallest thing has clearly further proper parts, but they are not considered in the given model. Therefore, a point may be identified as

the smallest thing within an arbitrary framework to which the bigger things converge, i.e. extend. Consider an abstractive set $\{y_1,y_2,y_3,\ldots,y_n\}$ whose members extend all over the succeeding members. That set converges to nothing since there is no a smallest thing. But the set can converge to a given member whose dimension is arbitrarily y small. Assume the symbol $\Rightarrow$ is for convergence and we can represent extensive abstraction in the following way:

$$y_1, y_2, y_3, y_4,\ldots,y_n \Rightarrow y_{n+1}$$

y_{n+1} is the aribitrary smallest thing we are interested in and thus it can be interpreted as the smallest member of the set. Using the very same method, one can identify the last part of a thing, i.e. its boundary. Let y_1, y_2, y_3, y_4,..y_n be proper parts of a given thing. Since such a thing has no points among its members it seems impossible to define its boundary. By extensive abstraction one of its proper parts can be arbitrarily taken as its boundary, i.e. where such thing ends:

$$PPy_1, y_2, y_3, y_4,\ldots,y_n\, x \Rightarrow By_{n+1}x$$

In this framework, then, it is possible define the contact of two open things as the situation in which there is an empty region no bigger than a certain arbitrarily designated dimension between the boundary of the two things where the dimension of the region and the boundaries of the thing are defined by extensive abstraction.

However, such picture suffers from two problems: (i) it admits abstract things within the domain of space; (ii) it does not permit a strong distinction between a thing and its complement and, thus, contact is vacuous.

The motivation behind (i) is straightforward: boundaries are sets of things which are, in turn, sets of smaller things and so forth. It is contradictory to admit abstract things within the domain of concrete ones, by definition. Moreover, abstract things are outside space and time and, thus, they cannot have causal force within a space and time domain. Therefore, boundaries are devoid of causal force and this is very counterintuitive[98]. I think that is a very deep problem for the proponents of that method.

Furthermore, according to (ii) within that framework it is impossible to make a strong distinction between a thing and its complement. I assume the following definition of distinction:

x is distinct from y iff x is not a proper part of y.

x is strongly distinct from y iff at least a proper part of x is not a proper part of y.

Consider Reddy and Blully as two open discrete dice of volume v^3. Since they have the same volume, according to the depicted view, neither of them is a proper part of the other. Thus, they are distinct. Since they are discrete they are supposed to be also strongly distinct. Consider a case in which they are at the two sides of an arbitrarily smaller empty region, Reddy at the west side and Blully at the east side. They are in contact. Since Reddy is open, there is nothing that prevents the «spilling out of it»[99] on its east side, namely there is no thing that is the last part of Reddy and thus since it has no last part, every thing that is on the east side of Reddy is part of it. Therefore, a part of Reddy has to meet a Blully

[98] *Mutatis mutandis*, you can employ the argument in § 2.4 in support of that claim.
[99] The metaphor is Sorensen's 1998: 284.

and then, unless they coincide, they properly overlap. In other words: they have at least a proper part in common. That means that they are not discrete and thus contact between them is vacuous.

3.3.2 Contact in a Discrete Space.

Perhaps the problem, as Kilborn (2007) argues, arises from the density of space. And, thus, a discrete space does not have such a problem. A space is discrete iff the finite extended region is composed of finitely many simple regions (McDaniel 2007a). Assume the same definition for things that are located in such a region.

Suppose that space is made out of regular simple two-dimensional cells and every thing is either as big as a cell or is a mereological sum of things located in cells. Two things are then in contact when they are adjacent, i.e. when there is no further thing between them[100].

It seems natural and easy. Consider Reddy and Blully as two big discrete simples and consider that there is no further discrete empty or full cell between them. It seems obvious that they are in contact.

Although this seems simple, contact within a discrete framework is vacuous for two reasons. First, it is impossible distinguish between two complex things within the framework, and, second, simples insatiate just one kind of relation, i.e. adjacency.

Let me begin with the impossibility of distinguishing between two discrete things. Suppose two adjacent squares R and B, each of them composed of four cells. Each of the cells of R is adjacent to the other three cells. The rightmost cells of R are adjacent to the leftmost cells of B. The relation of adjacency between the rightmost cells of R and the leftmost

[100] For a mereotopological theory with adjacency as primitive and space as a sum of cells see Galton 1999.

cells of B is virtually indistinguishable from the relation of adjacency between the leftmost cells of R and its rightmost cells. Unless one does not provide an arbitrary special closure of the relation of adjacency, it turns out to be impossible to distinguish the cells of R from the cells of B; therefore, contact is vacuous for it happens in the same way between connected and discrete things.

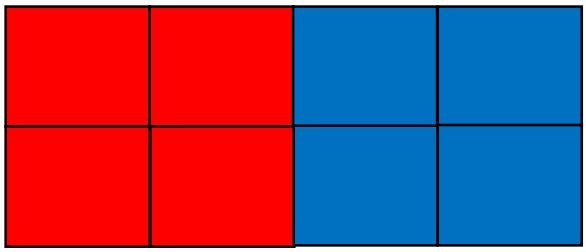

Figure 4. Two squares in discrete space.

Furthermore, let us consider two simple adjacent cells. Are they in contact? Since they cannot overlap or be connected insofar as they have no proper parts, every relation they can have with another thing is the relation of adjacency. Therefore, contact collapses to adjacency and so does every other possible relation they may have. Contact is, thus, a vacuous relation for it is the only kind of relation a simple may have with another simple.

PART 2.

LIVING IN A *FIAT* WORLD.

4. Breaking Down Boundaries.

> "Ru-h-ru-h-ru-h-h-h-h. Pooh-ooh-ooh. Tick-tick-tick-tick. Pre. R-r-r-r-r-uh-h. Huh! Bang. Su-su-su-ur. Booh-a-ah. R-r-r-r. Pooh…multitude of sounds, all mixed together. Motorcars, buses, carts, carriages, people, lamp-posts, trees.. ..alm mixed together; in front of cafés, shops, offices, posters, shop windows: multitude of things. Motion and standstills: different movement. Movement in space and movement in time. Multitude of images and all sorts of ideas. Images are veiled truths. All different truths form what is true. What is individual does not display all in a single image...Ru-ru-ru-u-u. Pre. Images are boundaries. Multitude of images and all sorts of boundaries. Elimination of images and boundaries through all sorts of images. Boundary clouds what is true. Rebus: where is what is true? Boundaries are just as relative as images, as time and space"
> Piet Mondrian, *The Grand Boulevards*.

The problems we encountered in finding the right account of contact may result from the controversial nature of boundaries. Perhaps, it is difficult explain how two things keep in touch since their boundaries are not strictly and literally "things" but rather features of our ways of representing the world. That is, the division of things into discrete units by means of boundaries is a sort of fiction. In what follows I claim that

boundaries are fictional things we employ for dividing reality in more wieldy units. That does not entail that reality is a fiction but that only its division in mutually discrete things is fictional. I call that theory Spatial Fictionalism, namely the theory according to which space is human independent whereas its division into discrete things is due to our conceptual scheme. It is not a form of idealism, rather, it is a weak form of antirealism about ordinary things. I develop this line of thought in detail in chapter 5.

In this chapter, I argue directly against boundaries as human independent things by means of two sorts of arguments: direct and indirect.

By direct arguments, I mean arguments that deny the existence of boundaries as things in space. These arguments simply try to reach the conclusion that boundaries do not exist *simpliciter*. In chapter 5, I articulate and defend that conclusion, arguing that they do not exist as *bona fide* things; rather, they are *fiat* things.

Here a list of the direct arguments I use:

4.1 Vagueness, i.e. boundaries are vague things and since vagueness is a feature of our representation of thing and not of thing themselves, boundaries do not belong to things themselves but rather to the representation of things.

4.2 Arbitrariness, i.e. even though some boundaries appear to be determinate, their position in space depends on our language or some conceptual schemes and, hence, they are metaphysically arbitrary.

By indirect arguments, I mean arguments that reach the conclusion that abandoning boundaries simplifies some other independent metaphysical theories and avoids certain kinds of paradox. It is worth

noting that the contact paradox was ruled out if boundaries were not posited. Here the list of arguments I develop in what follows:

4.3 Diachronic Identity, i.e. the paradox of diachronic identity is an outcome of positing boundary. Therefore, eliminating boundaries is the solution to avoid the paradox.

4.4 Ontological Parsimony, i.e. a metaphysical theory without boundaries is more ontologically parsimonious than every other alternative that posits boundaries.

4.5. Grounding Problem, i.e. how is it possible for two diverse things to share the same region of space at the same time.

In the final part of that chapter, I argue that theories without boundaries are also theories without things. Eventually, I reply to an objection raised by Sorensen (1998).

4.1 Vague Boundaries.

The argument from vagueness and the paradox it generates, i.e. the Sorites Paradox, can be traced back to earliest period in the history of philosophy. Its first formulation was articulated by the Megarian logician, Eubulides of Miletus. Very briefly, the argument from vagueness is that the impossibility of determing the limit of a given thing entails that every thing is a part of that thing.

The argument from vagueness is nowadays often employed to deny the existence either of specific classes of things, or of specific doctrines about things. In particular, famous versions of it are employed for denying the

restriction of mereological composition (Lewis 1986; Sider 2001)[101], for eliminating ordinary things (Unger 1979; Heller 1990), and for defending existential monism (Horgan and Potrč 2008). The argument was also employed by Varzi (2001) directly against boundaries. I follow here his reconstruction of the argument and I then provide a new reason to use it against boundaries[102].

Consider the outline of a thing, such as Reddy: it is supposed to be located in a region that is the last region in which Reddy has a part. Suppose you have to find that region. One way may be to start to determine which part belongs to Reddy, since its boundary is its last part and hence there are no parts of Reddy beyond it. Surely the point[103] that is at the center of the interior of Reddy is one of its parts. We can then suppose that also the point that is adjacent to it is part of Reddy, and the one that is adjacent to the previous point and so forth without end. Therefore, every point that exists is part of Reddy.

Let R be Reddy and let $(a_1 \ldots a_n)$ be the series of points from the point in the center of the interior of Reddy until an arbitrary distance point. Here is a more rigorous version of the argument:

1. $R(a_1)$
2. $R(a_1) \rightarrow R(a_2)$
3. $R(a_2) \rightarrow R(a_3)$
4. $R(a_{3+n}) \rightarrow R(a_n)$
5. $R(a_n)$

[101] For a reconstruction of the argument, see Korman 2010.
[102] For a general introduction of the issue of vagueness and its philosophical and logical treatments, see Williamson 1994.
[103] For the sake of simplicity, I assume here points and the discreteness of the space. Nevertheless, the argument also works well in a Whiteheadian space. Furthermore, I employ the argument exclusively within the spatial domain. For a different employment, see Williamson 1994.

The argument shows that since little variation does not make the difference, there is, thus, no cut-off point that is the last point of Reddy and that is the reason why a point at an arbitrary distance of Reddy is part of it. That is, the argument finds its motivation in an implicit premise: the little-by-little inference: that is, a recursive inference that states that a little difference does not make the difference:

Initial rule: if y is adjacent to x and the y belongs to z then also the x belongs to z.

Successor rule: for any x, if x is adjacent to y and y belongs to z then x belongs to z.

The argument then reaches the no cut-off conclusion: a complex x does not have a last part. By universal generalization: for any complex x, x does not have a last part. Therefore, boundaries do not exist.

Nevertheless, it is possible to resist that conclusion in various ways. One of the most famous is to accept vague boundaries: it is incorrect to infer from the fact that it is impossible to fix the cut-off point of a thing that such a thing does not have a boundary. That is, it is possible to establish what belongs to such a thing, for instance, its most interior point, and what does not belong to it, for instance a point at an *n* distance from it. Moreover, there are cases where it is vague whether or not something belongs to such a thing, that is, borderline cases of parthood. The boundary of that thing is then a vague strip that includes things that are determinate parts of it and things where it is indeterminate whether they belong to it. That is, parthood comes in degrees, contrary to the assumption of precision I make in § 1.1.6.

The very problem with this conclusion is that it entails that some things are not ontologically determinate. Suppose you consider an x that is located within the vague stripe of y; it is indeterminate whether it belongs to x. And since vagueness is recursive, there are some things where it turns out to be indeterminate whether they belong to the vague stripe, and so forth. Since such a solution appears to be possible also given my definition of boundaries, it cannot be ruled out *a priori*. But I think there is a way to resist the conclusion that vague things exist. We can resist it by showing that vagueness is a semantic and not an ontological fact. Therefore, such vague strips are not part of the furniture of the world but rather of the representation of it[104]. Assuming vagueness as an ontological fact I argue led us to the following two contradictions.

Let x be a complex thing whose boundary y is vague. Assume also y is a complex thing. The outermost part of y is vague, i.e. it is intederminate whether some given thing belongs to y. What about the part of y that is connected with the interior part of x? Since it is part of y, it has to be vague too. Since it is vague, via a Sorites' argument, it is provable that the most interior part of x is part of y, which is the outermost part of x. That is a contradiction.

Consider two discrete complex things x and y. Since they are discrete, they have no parts in common. Suppose they are at some fixed distance *n* from each other. Since they are ontologically vague, or at least their boundaries are so, it is provable via a Sorites' argument that the interior part of y is one of the proper parts of x. That is a contradiction.

If vagueness is just a semantic fact the two contradictions may be avoided for it is just our usage of some words that is contradictory and not the world itself.

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[104] The *loci classici* against vagueness as ontological fact are Russell 1923 and Evans 1978. See also Sider 2003.

Thus, since boundaries are vague and vagueness is not a feature of the world, boundaries do not belong to the world but rather to our representation of it.

4.2 Arbitrariness.

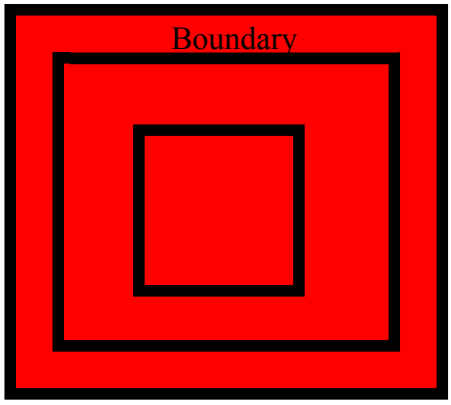
If boundaries belong to the furniture of the world, they are not metaphysically arbitrary, in the sense I developed in paragraph 3.2.1.1. What I argue here is that they are, rather, fixed in an arbitrary way. That is, the mereological fusion of simples that may be the boundary of a given thing is just an arbitrary fusion of simples.

Let us assume that the boundary in question is not vague. Let Reddy be a complex fusion of simples and let East be its east boundary. According to the definition of boundaries I gave, East is an external proper part of Reddy and every internal proper part of Reddy either overlaps it or overlaps something that overlaps it. Since Reddy is made up of simples, overlap is vacuous: partless things cannot have parts in common. Nonetheless, we can redefine overlap for simples as a sort of adjacency:

Simples overlap: x and y overlap iff the region of x is connected to the region of y.

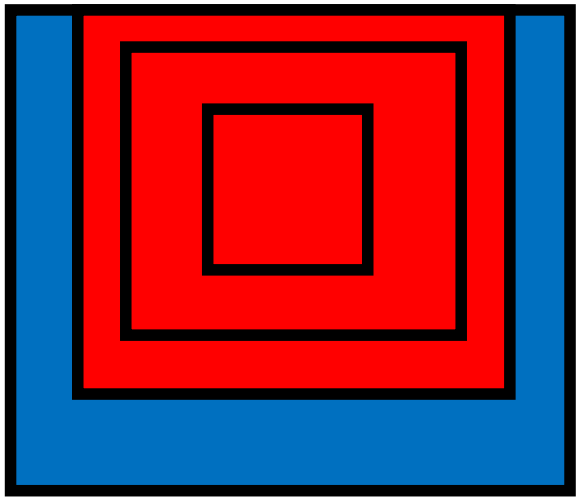
In such a way, East is the fusion of simples which is located at the easternmost proper subregion of the region of Reddy.

For finding a boundary of a thing, then, it is only necessary to find its outermost region. And its outermost region is the region that is connected just to one direction, namely to the interior of the given thing, as in picture 5.



Suppose now you move Reddy from its region to another one. And suppose the outermost subregion of the new one is far from the outermost part of Reddy. In this case is the thing located in the outermost subregion of the new region the boundary of Reddy? It seems that such an answer is at odds with our commonsense. One can say that: the boundary of the thing is located at the last subregion occupied of the region in which that thing is located. Hence, even if the last subregion of the region is far away from the last part of Reddy it is not a problem as soon as it is empty.

Suppose now that the outermost part of the relevant region is adjacent to the last region occupied by a part of Reddy and suppose that such region is filled by a continuous layer of simples as in picture 6.



In this case, it seems that we have to choose between two candidates for the role of boundary: which one is the boundary of Reddy? I guess that every answer to that question is arbitrary as soon as we use the definition of boundary we have.

Can we change our definition of boundary? As I argued in chapter 2, every other solution is insufficient and thus we cannot.

4.3 Diachronic Identity.

The paradox of diachronic identity is a well-known puzzle that belongs to a family of philosophical conundrums[105] that has its roots in the beginning of philosophy. What I argue here is that: the paradox is originated by the posit of the existence of boundaries. In fact, a boundaryless world does not suffer of such paradox.

The paradoxical argument reaches the conclusion that a thing cannot survive change over time, unless one rejects either the transitivity of the identity or the mereological assumption that a proper part is smaller than the whole which it belongs to. In a more rigorous way:

[105] In § 4.5 I face another paradox that belongs to such a family: the paradox of material constitution.

1. Leibniz's Law: x and y are identical iff they share all the same properties.

2. Transitivity of identity: if x is identical to y and y is identical to z, then x is identical to z.

3. Reddy at t_1 has a volume n^3. At t_1 the volume of one of the proper parts of Reddy is n^3-x^3. Let us call that part Redd*.

4. At t_2 Reddy loses its bulk boundary and then its volume becomes n^3-1^3. Let $Reddy_2$ be the label of Reddy at t_2.

5. ∴ Reddy=$Reddy_2$ and $Reddy_2$=Redd* and Reddy=Redd* (from 1,2 and 4).

6. ∴ Reddy≠Redd*. (from 1 and 3).

There are many ways to avoid the paradox: indexing identity over instants of time, different senses of identity in the different premises of the argument, a non-standard ontology of time. Discussing that is beyond the aim of the dissertation[106]. What I suggest here is that eliminating boundaries is one easy way to solve the paradox. Indeed, in a boundaryless world, literally speaking of change over time would belong to our conceptual scheme rather than to the world itself. Consider Reddy, since it has no boundaries, and, thus, no faces, the calculus of its volume would be impossible: it is meaningless to say where it spatially begins and where it ends, and, thus, it is impossible to calculate its volume. The same is, by analogy, valid for every kind of change: since it is impossible to literally identify a thing, it is also impossible to strictly identify its changes[107]. Therefore, the paradox disappears.

[106] The way I suggest is not the only possible solution to the paradox. For a list see Gallois 2016.

[107] In the next chapter I argue that such impossibility is just *de re* and not *de dicto*.

4.4 Ontological Parsimony.

Resisting boundaries provides both kinds of ontological parsimony[108]. Let me outline them one by one:

(i) quantitatively ontologically parsimonious: a boundaryless theory of the world minimizes the number of things since within the framework it is strictly impossible identify them. Such a theory entails a form of monism insofar as it is impossible to discern the things that compose the world from the world itself.

(ii) qualitatively ontologically parsimonious: such a theory reduces the kinds of things there can be since there are no distinctions between boundaries and other kinds of things in space. Whereas a theory that posits boundaries has to make such a distinction.

4.5 The Grounding Problem.

Consider a putative instance of ordinary thing, as a statue of clay. It occupies a certain region of space during every instant of its career: now is here, then is there. When «here» or «there» are filled by the statue, no other thing but the statue can occupy «here» or «there». The moral is that two distinct things cannot occupy the same region at the same time. One can think that there is a sort of metaphysical law that bans co-occupation. I call it No Co-occupation Law (NCL).

Despite a wide endorsement among humans, NCL is denied by almost every philosopher[109]. Indeed, its negation is called the «standard account» (Burke 1994). One of the usual arguments against NCL runs as follows (Gibbard 1975): Consider a statue and the lump of clay it is made

[108] See paragraph 2.1.4 for an explanation of the various kinds of parsimony.
[109] According to the survey in the literature due to Wasserman 2015.

of. Even if the statue and lump of clay share all the same parts and a lot of other properties, they are different under many respects: aesthetically, modally, temporally and so forth. The content of that region satisfies at least two mutually inconsistent sets of properties at the same time. Since the very same thing cannot be the source – or cannot be the owner – of two inconsistent proprieties, when it is the case, there are two different things, each of which corresponds to one of the inconsistent properties. In this case: a statue and a lump of clay. Each of these sets fixes the identity conditions for a particular singular thing (Sidelle 2016).

It seems that we should revise our intuitions and give up NCL. Thus, the content of that region is both a statue and a lump of clay.

But here some problems arise: how is it possible for two things to be coincident? What grounds their difference given that they share all the same material properties? How is it possible for more than one thing to be composed of the same parts[110]? Usually, questions of this sort compose what is called the Grounding Problem (Bennet 2009).

There are two kinds of solution to the grounding problem: either accept colocation and try to explain the difference, or reject colocation and try to respond to counterexamples.

There are several ways to explain colocation, but I do not find any of them completely compelling: they have too generous ontological commitments and very extravagant metaphysical consequences. I also think that giving up NCL is too extreme a revision of our intuitions. As Noonan (1988: 222) said, it is a bad case of double vision.

So, whereas most philosophers try to ground the difference among coincident entities, my aim here is to defend NCL against its counterexamples, showing that there is no inconsistency among sets of

[110] I show later that sharing parts entails co-location, but the converse does not hold.

properties in a given region when there are no boundaries. I will argue that because things depend upon their boundaries, in a boundaryless world, there is no grounding problem to solve, since it turns out to be impossible distinguishing between an object and stuff of which it is made of.

There are several other ways to defend NCL. Let me just mention the more relevant in the recent debate: causal overdetermination (Merricks 2001, 2017; Sider 2003); counterpart theory (Lewis 1986, 2003); conventionalism about modal properties (Heller 2005; Einheuser 2011); four dimensionalism (Sider 2001); hylomorphism (Koslicki 2008); incompatibility with classical extensional mereology (Sider 2007); mereological nihilism (Unger 1979; van Inwagen 1990); the modal supervenience thesis (Sider 1999; Olson 2001); sortal dominance (Burke 1994; Rea 2000); stuff ontology (Sidelle 1998).

My strategy is as follows, I begin by stating the No Co-occupation Law and the counterexamples it has to face (4.5.1). I then outline the counterexample to NCL (4.5.2) and how it gives rise to the grounding problem (4.5.3). I sketch some famous ways of defending NCL, showing why they fail, or why they are inadequate on independent grounds (4.5.4). Finally, I set forth the solution I claim (4.5.5).

4.5.1 No Co-occupation Law.

Let me state what I call No Co-occupation Law (also known as No Coincidence law and No Co-location law): two different things cannot occupy the same region of space at the same time. In case of violation of that law it is said that two things coincide.

The principle of no co-occupation formalizes a very intuitive concept: If a thing occupies a region at a given time, whatever there is in such

region at that time is that thing. For instance, suppose I lose my phone. In order to find it I just need to discover its actual spatial region. And, obviously, also the converse holds: if I find my phone, I bump into its region as well. How many other things can I find in that region before I move my phone to my pocket? None, for NCL maintains that identity of location is sufficient for identity in general. Clearly, you can find beyond the phone, all of its parts. But since NCL entails extensionality, i.e. the thesis according to which an entity is just its parts taken as a whole, it is not a problem at all[111].

Yet, sharing location is not necessary in order to be the same entity. Consider a Max Black's world, namely a world in which two otherwise indiscernible spheres are located in two different regions. These regions have the same size and shape. The two spheres also have all the other properties in common: color, mass, and so forth. Are they the same entity? NCL does not say anything about it, insofar as it neither bans, nor affirms multi-location, that is, the thesis according to which two things may be identical, even if they do not share the same region.

[111] See § 1.1.3 for the formal statement of extensionality. Suppose that, by *reductio*, NCL does not entail extensionality. Consider a complex region r at t, i.e. a region with proper sub-regions. Consider its occupants, a set of topological connected things. Since we have assumed mereology, there must be a principle of composition, otherwise we cannot strictly and literally speak of parts and sub-regions. Thus, such things compose at least one further thing. Unfortunately, unless such a principle does not entail extensionality itself, there is nothing that prevents two such things from fusing in more than one further thing. Therefore, the same region is occupied by more than one thing at the same time and NCL is violated. Contradiction. You can find instances of violation of NCL due to the lack of extensionality in, *inter alia*, Fine 2008, Einheuser 2011, Sutton 2012. They all either prove or assume that the same parts can compose more than one thing. Nevertheless, extensionality does not entail NCL. Suppose extensionality holds and NCL does not. A thing x occupies a region at a time, and all of its parts compose just that thing. Nonetheless, nothing rules out s that a thing y, discrete to x, goes through x. For instance, it is surely possible that a ghost goes through a wall, thus sharing the same region with the wall although they do not share the same parts. Even if you do not believe in extensionality, you do not need to give up NCL, since a hylomorphist may also hold such principle. See Koslicki 2008.

According just to NCL two things that share the same region are the same. But they may not share their region and nevertheless be identical. There is nothing in NCL that rules out such a possibility. NCL is a tensed instantiation of the Principle of Identity of Indiscernibles referred to regions and their occupants:

(PII) For every x, for every y, if x is P iff y is p, then x is identical to y.

$$\forall x \forall y (Px \leftrightarrow Py) \longrightarrow x=y$$

PII claims that sameness of properties entails sameness in general, but it does not claim the converse, that is, the Principle of Indiscernibility of Identical, which instead states:

(PII*) For every x, for every y, if x is identical to y, then x is P iff y is P.

$$\forall x \forall y (x=y) \longrightarrow (Px \leftrightarrow Py)$$

Its locative tensed instantiation would claim that two entities are the same iff they share the same location in space at a given time. Hence, it would ban multi-location.

Thus, a good formalization of NCL can be as follow:

NCL

$$\forall x \forall y \forall r_t (Lxr_t \leftrightarrow Lyr_t) \longrightarrow x=y$$

For every x, for every y, for every r at t, if x and y are co-located, then they are identical.

Although NCL seems to capture our intuitions in following PII, there are two other ways to formalize NCL that modify its modal strength[112].

NCL is consistent with what Fine (2003) called extreme monism. According to Fine, monism is the thesis according to which coincident entities are the same. Monism can be accounted in three different and not equivalent forms. Extreme monism is the view that two entities that are coincident at a time are the same, moderate monism states that two entities that coincide in a world are the same, and mild monism states that two entities that are necessarily coincident are the same

For the sake of simplicity I here assume just NCL as a formula for extreme monism. Nonetheless every argument against NCL works well against all the other versions of monism. Therefore, my final response to its critics can also be applied on behalf of each of its other formulations.

4.5.2. Against NCL.

Critics of NCL can be divided into two main categories: (i)those who believe that NCL does not hold in the actual world and (ii) those who believe that it may, but that it is not necessary.

Those who believe NCL is not valid even in our world, usually argue that every region, when occupied, hosts at least two things: an object and the stuff of which it consists (Burke 1975; Wiggins 1968; Fine 2003). Some of them argue that every region can host an object and a large number of events, e.g. a ball, its rotating, its getting warm and so on (Casati and Varzi 1999; Davidson 1969).

Those who believe that NCL can be valid in our world, although it is not necessary, i.e. there are at least a possible world in which NCL does

[112] The two formulations of NCL might be instantiations of two non standard ways to formalize PII.

not hold, argue that the matter of which a thing consists may be penetrable. If so, two things can interpenetrate. In other words, two things can coincide. Here I defend only the possibility of NCL, even though I mention something about the necessarily aspect.

Consider Wiggins (1968) who argues that since things and the stuff of which they are made are modally different, they share the same region at the same time without being identical. Imagine a tree and the aggregate of wood of which it consists and suppose that one wood cell is destroyed. Clearly, the tree can survive such event, whereas the aggregate of wood cannot. *Mutatis mutandis*, consider the case in which the tree is cut down and eventually transformed into a table, without losing any cells. Contrary to the former example, the tree ceases to exist, while the aggregate of wood survives[113,114].

In its very general form:

1. $Lxy_t \wedge Lz_t$ (assumption)
2. $x=z$ (from 1 and NCL)
3. $Px \wedge \neg Pz$ (assumption)
4. $x\neq z$ (from 3 and PII)
5. $x=z \wedge x\neq z$ (contradiction from 2 and 4).

In order to avoid such counterexamples, one can either narrow the scopes of quantifiers to sortals, or provide a mereological version of NCL:

[113] NCL also fails if one accepts as possible one of the two following cases: «The tree may have been constituted of a different stuff», «The wood may have constituted a different thing».

[114] The argument due to Wiggins is equivalent to the one due to Gibbard mentioned in the §4.5.

Sortal relative-NCL (SR-NCL):

$$\forall x \forall y \forall r_t ((Sx \wedge Sy) \wedge (Lxr_t \leftrightarrow Lxr_t)) \longrightarrow (x=y)$$

For every x, for every y, for every r at t, belonging both to the same sortal s, for every region r, if x occupies r at t and y occupies r at t, then x is identical to y.

Mereological version-NCL (MV-NCL):

$$\forall x \forall y \forall r_t (Lxr_t \wedge Lyr_t \longrightarrow Oxy)$$

For every x, for every y, for every region r at t, if x occupies r at t and y occupies r at t, then x overlaps y.

That is, SR-NCL states that two different things can share the same region as long as they do not belong to the same sortal. Since two different trees are both ordinary things, they cannot be co-located, whereas a tree and wood of which it consists can be so, insofar as wood belongs to the sortal «stuff». Such a version of NCL may also allow that a thing and an event can share their location. A ball and its rotating is a perfectly admissible case of co-location (Davidson 1969), because they belong to two different sortals.

The MV-NCL states that x and y can be co-located just in case they have all their parts in common in r at t. If so, since the tree and the wood of which it consists share all their parts, they do not contravene the principle[115].

Both SR-NCL and MV-NCL appear to be very intuitive principles. Nevertheless the fact that two different things that do not overlap or belong to the same sortal cannot be co-located, may be a contingent fact due to the physical laws of our world (Zimmerman 1996; Sider 2001).

[115] SR-NCL and MV-NCL are not equivalent. The proof is trivial.

If so, the modal strength of NCL has to be weaker:

$$\Diamond\forall x\forall y\forall r\ (Lxr \wedge Lyr \rightarrow x=y)$$

Weak-NCL: Possibly, for every x, for every y, for every region r, if x occupies r at t, y occupies r at t, then x is identical to y.

Weak-NCL may also be challenged in various ways by assuming one of the following principle:

(a) Necessarily, every thing is made of stuff.
(b) Necessarily, every amount of stuff constitutes a thing.
(c) Necessarily, there are scattered things.

According to (a), ephemeral things as ghosts and abstract things such as numbers are necessarily outside space and time, because only things made of stuff can exist in space. Thus, every inhabited region hosts a thing and its stuff as a matter of necessity. According to (b) there is no fixed minimum amount of stuff needed to be a thing. If so, every lump of stuff counts as a thing, no matter how large it is. According to (c) things are composed of topologically disconnected parts, regardless of whether such parts are close to each other. Thus, a little lump of stuff also counts as thing insofar as it is a part of a bigger one.

Therefore, also Weak-NCL may be sortally or mereologically relativized, in order to avoid such counterexamples.

Sortal relative-Weak NCL: Possibly, for every x, for every y belonging both to the same sortal, for every region r, for every instant t, if x occupies r at t, y occupies r at t, then x is identical to y.

$$\Diamond\forall x\forall y\forall r_t\,(Sx \wedge Sy \wedge Lxr_t \wedge Lxr_t) \longrightarrow (x=y)$$

Mereological relative-Weak NCL: Possibly, for every x, for every y, for every region r at t, if x occupies r at t and y occupies r at t, then x overlaps y.

$$\Diamond\forall x\forall y\forall r_t\,(Lxr_t \wedge Lyr_t \longrightarrow Oxy)$$

Such relativizations may seem in substantial agreement with our modal intuitions, either way.

Nonetheless, giving up the original, stronger formulation of NCL, turns out to be a source of modal problems.

4.5.3 The Grounding Problem.

Consider what is called the Grounding Problem (GP) (see, *inter alia*, Olson, 2001; Fine 2003; Bennet 2009a, 2009b; DeRosset 2011; Einheuser 2011; Sutton 2012; Sidelle 2016):

(GP): how is it possible for two co-located things to share all the same parts, shape, size, mass, causal history, and so forth, and nevertheless be different?

Consider the putative example due to Wiggins about the tree and the cellulose. Since the two co-occupants share all the same material actual parts they seem to be the same thing, perhaps differently described. Unfortunately, they differ in some of their modal properties and in some of their persistence conditions, as I noted above. Some properties appear to be *de re* and not *de dicto*. Thus, assuming PII, tree and cellulose are different. So, there are two different things with all the same parts, shape and location that are nevertheless different.

What grounds such difference? It seems natural to think that modal properties and persistence conditions are grounded on or depend upon the actual and the material ones. In spite of the intuition, tree and cellulose share all the actual and material properties and nevertheless are different. How is it possible?

The right way to avoid such a conundrum seems to be to resist the counterexamples to NCL. Indeed, NCL would prevent GP for it denies that a region of space can host more than one thing. Whereas all the other narrower or weaker formulations obviously do not.

Nonetheless, even if one were to reject all the counterexamples, the GP can be refined in order to challenge also NCL.

GP*: how is it possible for the very same portion of reality to be the source – or to be the owner – of two inconsistent sets of *de re* modal properties?

The problem is deeper than it seems, since according to PII every set of properties picks out from reality a certain thing. In order to have two different thing it is only necessary that they differ in one property, even if they share all the others. Therefore, when two properties are mutually

inconsistent, there are two entities, as a consequence of PII. Let me expose the argument in more formal way:

1. $Px \wedge \neg Py$ (assumption)
2. $\forall x \forall y(Px \leftrightarrow Py) \longrightarrow x=y$ (PII)
3. $x \neq y$ (from 1 and 2)

Consider again the example due to Wiggins: the first set collects all the modal properties we attribute to objects: «possibly, it survives annihilation of one part», «necessarily, its parts are topologically connected»[116], and so forth.

The second set collects all the modal properties we attribute to lumps of stuff: «necessarily, it does not survive the annihilation of one part», «possibly, its parts are not topologically connected », and so forth.

The problem is deeper than it seems, again. The things do not differ just in some properties, they differ in the properties that define what such things are. As noted in § 2.6.3 such properties are called sortal properties, i.e. the properties that fix the identity of a thing. In order to avoid metaphysical arbitrariness, there are as many sortals as many consistent intersections of modal properties and persistence conditions are possible.

Intuitively, modal properties and persistence conditions depend upon or are grounded in the actual ones. But it seems that it is not so, since the very same actual properties produce inconsistent modal properties, as

[116] That turns out to be true just in case one does not believe in scattered objects. In such case it can be reformulated as «necessarily, the distance among its parts is some fixed *n*».

in the case of tree and cellulose or statue and lump of clay. What is to be done about this inconsistency?

The solution may be to employ a non classical logic. For instance, suppose the glutty one, according to which some mutually inconsistent sets of properties are perfectly admissible. Say, the very same thing x has both the property P and not P in the very same way in which it has all of its other properties. Even if its metaphysical price is high, such local application of a glutty logic seems to be fine in order to solve GP: you have a thing with, say, two inconsistent persistence conditions but it is admitted by your logic, since it permits a kind of contradiction like this. Thus, the problem seems to be solved. The explanation of the owning of such properties it has nothing special in respect of the explanation of owning properties in general. A problem arises here. The two sets of properties are not just inconsistent, they are also the source of two different things, since they define two different sortals. Hence, a glutty logician cannot defend NCL[117].

Thus, even employing a glutty logic the problem reappears: there are two entities in the same region, regardless of the underlying logic.

Beyond that attempt, there are three different sets of solutions: either (i) accepting the inconsistency and rejecting NCL, hence providing a reason for the modal difference instantiated by the same portion of reality; or (ii) rejecting the inconsistency and trying to defend NCL to its critics in order to motivate how the content of one region may instantiate two different sets of properties without contradiction; or (iii) denying one or both sets of properties and thus defending NCL.

[117] A philosopher who believes in an application of glutty logic, may insist. She may hold that a thing can belong to two mutually inconsistent sortals, and so that thing may be a tree and a lump of cellulose at the same time. It may be a solution, but it seems to me at least odd.

Since I find NCL more compelling than its negation, I argue for a solution that preserves the law responding to its critics, so I would like to find a solution within (ii) or (iii)[118]. I want to list and then reject the already noted solutions to the problem of how to preserve it, and finally argue for my strategy.

4.5.4. Main Solutions.

Let me briefly sum up: our ordinary intuitions sway us toward NCL. Nevertheless, some counterexamples deny NCL.

I claim that NCL is valid and there is something wrong in the assumptions or in the inferences implicit in the counterexamples against it. But I am in good company. Many other philosophers have tried to defend NCL against its counterexamples. However, I do not find any of the already known solutions really compelling. In what follows I list and then briefly reject some of them[119].

The following list of arguments can be divided into four subsets on the basis of the conclusions they reach. Some of them may belong to more than one subset:

1. There is no fact of the matter about which thing there exists and which not;

[118] Interesting solutions to kind (i) are in Fine 2004, Bennet 2009a. What is called «constitutionalism» or «standard view» usually holds that the same region is occupied by a thing and its stuff and they are linked by a relation calls «constitution relation». Such relation is irreflexive and asymmetric. That is, anything constitutes itself and if x constitutes y, then y does not constitute x. It is beyond the aim of the paper to explore such solutions. For a more generous list of this kind of solutions, see Sidelle 2016.

[119] Let me briefly say why I have excluded from the catalogues two of the most famous solution: deflationism (Hirsh 2005) and relative identity (Geach 1962, 1967). I rule out such theories, for I maintain that the problem we are discussing is really a metaphysical one and not just a verbal dispute, as a deflationist and a relative identity theorist would say.

2. One of the coincident things does not exist;

3. Exactly one of the coincident things does not exist.

4. There is more than one thing but that fact does not contravene NCL.

The arguments in the first set (*b*,*c*) endorse the thesis according to which the identity across time and world may depend on certain factors, e.g. according to Lewis, counterpart relations and according to Heller (2005), humans' beliefs. They argue that since the essence or the sortal membership is different from world to world or from convention to convention, there is strictly and literally no coincidence.

The arguments in the second set (*a*,*c*,*g*,*h*) may be employed for denying the existence of whatever thing we want: either ordinary objects, or lumps of stuff, or simples arranged thing-guise. It just depends on what ontology one supports. Nonetheless, such arguments were employed in literature to deny the existence of certain kinds of entities. For instance, *a* was employed by Merricks (2001, 2017) to rule out ordinary objects. Nevertheless, the arguments in the second set can be reformulated in order to deny another kind of things just replacing the subject of the premises. I guess such variability of the conclusion is an intrinsic weakness of such kinds of arguments.

The arguments in the third set (*e*,*f*) may be employed just to deny a particular kind of thing. In that case it is impossible to replace the subject and still have a valid argument.

The arguments in the fourth set (*b*,*c*,*d*,*g*) reach the conclusion that even if there are two or more things in the same region, that is not a proper violation of NCL, since, say, the co-located things are just overlapping parts of bigger things.

a. Causal overdetermination (Merricks 2001, 2017; Sider 2003; Horgan & Potrč 2008):

1. Object and lump of stuff[120] do the same causal work;
2. Just one is needed to preserve the wordly causal chain;
3. Therefore, one of them does not exist.
4. NCL is not violated.

Those who support the causal overdetermination argument against co-occupation, usually implicitly, or sometimes explicitly, assume that to be is to be causally active. In fact, the argument can be undermined if causal interties things exist. If so, one can say: well, just one between x and y causes z, but such arguments do not prove that there exists only one between x and y. It is possible that both exist but that only one of them is causally efficacious. That's only half of the story. Suppose one is really sure that existent things are just causally efficacious entities. The problem now is to understand in a non arbitrary manner which one between x and y causes z. I think there is no fact of the matter that permits us to decide which one between tree and cellulose causes my pain when I walk into them. Consider a counterfactual analysis of causation: «x causes z, iff had x not occurred, z would not have occurred». Which one between tree and cellulose has to replace x? Usually, it is argued that the smallest entities are more fundamental than the biggest ones. Cellulose, arguably, is just a plural name for collection of atoms, therefore cellulose exists and tree does not.

[120] According to Merricks (2001, 2017) the candidate is an aggregate of simples, i.e. things without proper parts, instead of a lump of stuff. At any rate, the argument turn out to be equivalent in its conclusion, namely one of the entity is an overdeterminer.

But, it is just an assumption, not a conceptual truth or a conclusion[121]. Hence, holding that smallest things are causally efficacious because they are more fundamental than the biggest, is begging the question since we are implicitly assuming two conclusions: 1. Smallest things are more fundamental than the biggest; 2. Fundamental things are causal efficacious, whereas derivatives are not.

b. Counterpart theory (Lewis 1986, 2003):

1. The thing x has counterparts x_1 and x_2: 1.1 x_1 is capable of surviving the annihilation of one of its parts, as a tree but not as a lump of cellulose; 1.2 x_2 is capable of crumbling away, as a lump of cellulose but not as a tree;
2. Tree and cellulose are not two things but the labels of two different counterpart relations;
3. Therefore, there is just one thing with two different counterpart relations.
4. NCL is not violated.

According to Lewis 2003:28, tree and cellulose are just two ways of describing the same portion of reality. Both the names label a sortal, each with some essential properties. Since essential or sortal properties are modal properties and since according to Lewis modal properties can be analyzed through counterpart relation theory, there is no problem at all. We have a certain portion of reality and two labels for it: according to

[121] Cotnoir 2013 labels the assumption priority. For instance, Schaffer 2010 argues for priority monism, according to which the whole, i.e. the biggest, is more fundamental than its parts, i.e. the smallest. Horgan & Potrč 2008 argues that there exist just one extended simple, that is the whole universe, precisely because the causal history of the universe can be reduced to the universe taken as a simple, instead of taken as collection of parts.

one label it has certain counterparts in certain worlds that behave in such and such ways and according to the other label there are other counterparts that behave in very different ways. Fair enough.

My problem with that solution is that it works only under a certain assumption: the two things diverge only in modal properties. As I noted, the two entities diverge even in persistence conditions: are those conditions modal properties or are they reducible to modal properties? If the answer is yes, then the solution by Lewis works well. Otherwise it does not. It is beyond the aim of the paper to try to capture the essence of persistence conditions. It is enough to say that the solution by Lewis works just in case persistence conditions are reduced to modal ones.

c. Conventionalism about modal properties (Heller 2005; Einheuser 2011; Sutton 2012):

1. Modal properties are just conventions;
2. There are no two sets of different modal properties, each of which define the existence of a new thing;
3. There is just one thing without modal characterization;
4. NCL is not violated.

The conventionalist approach is very similar to counterpart theory. Both theories hold that modal properties are reducible to something else: in one case conventions; in the other case counterpart relations[122]. Here the problem is again the one mentioned above: are persistence conditions modal properties?

[122] According to Heller 2005 counterpart theory can be employed by conventionalists for their purposes.

Moreover, conventionalists have to explain why and how the very same portion of reality admits two mutually inconsistent modal descriptions, that is a GP for conventionalists. It seems to me that there is still much work to be done.

d. Four dimensionalism (Sider 2001):

> 1. Things have four dimensions: three spatial and one temporal. That is, beyond spatial parts they also have temporal parts;
> 2. Two co-occupants are not two things in the same region, rather they are two particulars with a part in common in that region.
> 3. There are no coincident things, but just overlapping particulars.
> 4. NCL is not violated.

Four dimensionalism is often presented as a good way of solving the problem. It gives us the resources to easily explain the problem: when it seems that two things coincide, it is just because they overlap. Thus, the coincidence is just a shared stage within the life of such things. Nothing mysterious. There are two problems with four dimensionalism: 1. Not every philosopher agrees with such an ontology and therefore it is controversial to adopt a controversial thesis to solve a controversial problem[123] 2. Consider a changeless world, namely a world where time passes but temporal things do not change. Consider a tree and the cellulose. Even though they do not change across time, they nevertheless may be different across possible worlds: the tree would have been made

[123] One of the *desiderata* of Burke 1994 is to avoid four dimensionalism.

of different stuff, the cellulose would have constituted more than one tree, and so forth. Hence, the problem reappears: what grounds such difference?

e. Hylomorphism (Fine 2008; Koslicki 2008):

1. Lump of stuff is a proper part of a thing along with its formal proper parts[124].
2. There are no two or more coincident particulars, rather just one composed of all of its parts.
3. NCL is not violated.

My worry with this position is twofold: 1. Since a thing may be constituted by more than one part, it can be constituted by more than one formal part or manner of composition. Since formal parts dictate the structure, it is at least possible that one thing owns more than one structure. There is nothing within the theories of Fine and Koslicki that can block such argument. Therefore we have more than one particular in the same region at the same time. 2. The ontology of a proponent of hymorphism resembles a Mainongian picture: a jungle instead of the Quinean desert. According to a hylomorphist, such as Kit Fine, there are more kinds of parts, formal and material, and more kinds of entities, material, formal and mixed entities, than in a mainstream Quinean ontology. Not only the ontology turns out to be richer. Also the ideology:

[124] Two clarifications are needed: 1. Kit Fine 2004 proposed a more sophisticated relation among parts, stuff and what he calls manner of composition. However, I do not need to explain his theory in detail because my worry is about the more general nature of the intuition about something not physical, such as formal parts or manner of composition. 2. Kit Fine does not endorse NCL, rather he rejects it. Nonetheless, his version of hylomorphysm seems to be a good candidate of solving GP respecting NCL, since its solution aggregates stuff and thing in only one entity.

following Kit Fine (1999, 2004) there is more than one mereological system and hence a very rich ideological commitment.

f. Mereological nihilism (Unger 1979; van Inwagen 1990[125]):

1. Parthood never occurs;
2. There is just one simple for every inhabited region;
3. Every region may host at most one simple.
4. NCL is not violated.

The main problem with nihilists is that they throw away parthood because of its controversial consequences and its uncertain status, but they accept simples, i.e. proper partless entities. As far as I am concerned, simples are as controversial as composed entities. I have also another worry: simples are constituted of a lump of stuff, thus employing the same old argument that there are two things in the same region at the same time. Hence, they have no serious way to avoid the challenge.

g. Modal supervenience thesis (Sider 1999; Olson 2001)

1. A thing's properties supervene on the properties of its microphysical structure.
2. Coincident things have the same microstructure.
3. Coincident things are identical.

[125] As noted in 1.1.5.2 van Inwagen is not a nihilist, as long as he believes that there exist at least some composite entities, i.e. organisms. However, van Inwagen denies the existence of a principle of composition applicable for non living entities and thus he can be labeled as at least a local nihilist.

There are many kinds of supervenience; given constraints of space, I cannot give reasons for rejecting each of them here. I would just say here that, as I noted above, there is no fact of the matter on the basis of which smaller parts are more fundamental than the whole itself or, at least, there is no general agreement about it[126]. Not even the converse holds for sure.

h. Sortal dominance (Burke 1994; Rea 2000):

1. When a lump of stuff composes an object, just one sortal dominates, the one with the most properties instantiated;
2. There is just one thing, the one whose sortal dominates the other.

According to Burke, the dominant sortal is the one with «the widest range of properties». Thus, since an object has every property of its constituted stuff and some other properties more, then the sortal of the thing is the dominant one. Even here my worry is twofold: 1. The fact that the sortal that entails the owning of more properties is the dominant one is either arbitrary or trivial. Arbitrary, since having more properties does not seem a reason for being dominant. Trivial, for one of the things may be part of the other one and then it is obvious that the whole has more properties than one of its parts. 2. Even if the sortal with more properties is the dominant, which one has more properties? What if the two sortals entail the same number of properties? It is perfectly admissible that there may be a case in which a lump of stuff and an object are indistinguishable: for instance, in a changeless world without humans,

[126] There is also no fact of the matter or empirical evidence that simples there exist. There is a big and controversial debate both in physics and metaphysics about it. See Hudson 2007.

an artwork and its stuff have the same number of properties, even though the properties are different. Another problem also arises: how many properties does a lump of stuff have? How many properties does an object have? Questions like these are still outstanding.

4.5.5 No Boundaries Solution.

Recall the problem: the same region of space hosts at least two different things: an object and a lump of stuff. Contrary to the intuitiveness of NCL. Moreover, it is mysterious how it is possible for two things to be different despite sharing region, parts, and, more generally, every material actual property. It is the problem I called GP.

Clearly, NLC would avoid GP, since it precludes the notion that two different entities may share the same region.

Rejecting boundaries solves the problem of holding NCL.

Suppose that the entity x that occupies r has the modal properties $m_1,..,m_n$ and the set of persistence conditions $c_1,..,c_n$. Suppose that modal properties and persistence conditions are consistent. Thus, x is a thing whose sortal properties are the ones resulting from the union of the two sets of modal properties and persistence conditions. Unfortunately, since there are no boundaries, x is virtually indistinguishable from its complement: there is no fact of the matter and no metaphysical way to pick up x, since there isn't anything that differentiates x from its surrounding.

Despite the fact that there is no *bona fide* difference between x and its surrounding, human beings single out x by means of a *fiat* act, namely through creating *fiat* boundaries. As I better explain in the following chapter, such an act picks out a portion of stuff with its set of properties: the resulting entity is just an arbitrary demarcation of space.

Thus, there is no difference between an object and lump of stuff: it is the same quantity of stuff picked out through time and across possible worlds in two different ways: the boundaries of an object are the results of certain actions due to certain aims and the boundaries of the lump of stuff are the results of different actions due to different aims. They share their region. But since they are just *fiat* things, they do not violate NCL. Fiat entities are just located in space but they do not occupy space. Thus, that region has just one host, namely a certain amount of stuff, whose spatial size is dependent upon its boundaries: it would be bigger if its boundaries had been drawn in a different fashion.

Consider an arbitrary object: its boundaries have to be so and so in order match the criteria fixed by our concept of thing. That is, for instance, they must preserve a certain shape, yet vague: certain imperceptible changes are admitted, whereas sudden changes are not. And so forth.

Consider a lump of stuff which such an object is made of: it has very different persistence conditions. For instance, the preservation of the shape is not one of its persistence conditions.

They are *bona fide* indistinguishable: if there are no boundaries, it is impossible to say where a thing has its surface and thus what is its shape. It does not entail that the shape is human-dependent. It just means that we pick one of the many possible shapes. Such selection is based on both decisions and the structure of our way of seeing the world; how our perceptions and cognition work.

They persist in different ways, for their persistence conditions are fixed by two different *fiat* criteria of drawing boundaries: those of the object states that the thing persists iff its boundaries are continuous through time without sudden changes; those of the lump of stuff state that a lump of stuff persists iff its boundaries include every part of which

it consists. In fact, an object ceases to exist iff its shape is modified and a lump of stuff ceases to exists iff one of its parts is annihilated. As I tried to show, such conditions depend upon boundaries. And boundaries depend upon *fiat* act.

Therefore, in a boundaryless world there is no grounding problem. One can say that the solution is as controversial as the problem itself, since in this framework there are no things. In the next chapter I will argue that even though there are no *bona fide* things, there are *fiat* things that behaves as *bona fide* things would behave.

4.6 Reply to Critics.

In his 1998: 278-280, Sorensen claims that even though markers of boundaries may be conceptual or illusory, boundaries itself are not so. He argues that: even if boundaries' markers are the outcome of some conventional or cognitive process, we cannot infer form that that boundaries themselves are conventional or illusory. He labels that as the "genetic fallacy": a conventional or illusory origin of a thing does not pass down such status to the thing in the future or to the future parts of that thing. Indeed, he argues that since a boundary of a thing can be objectively measured, that boundary has to exist human-independently. Indeed, its properties, such as length, are objective despite the fact that its marker is not. To sum up: even if a thing has its origin in a convention or in an illusion, if the future thing or its future parts own their properties objectively, then that thing is human independent.

We can call the inference from the objective properties to the objectivity of the thing "objective inference":

If x is P and P is objective, then also x is objective. For any x, if x is objective, then x is human independent.

I think that is another kind of fallacy that I call the "objective fallacy", that is, inferring from the objectivity of the properties of a thing that such a thing is not conventional or illusory. Consider the cuts of beef, for instance, the rib. A rib has objective boundaries with objective length: it belongs in a part of the beef and ends exactly in another part. Nevertheless, such length is an outcome of a convention that identifies an arbitrary limit to a part of beef. Indeed, there are many different ways of cutting the beef. And, thus, even though it has objective dimension, it is not itself objective[127]. The same goes for every objective property: even if x is objective P, it cannot be inferred that x is human independent.

[127] See also Borghini 2014, according to whom such cuts are instead "action boundaries", that is, boundaries whose nature is dictated by acts. I discuss such a doctrine in depth in the following chapter.

5. *Fiat* Boundaries: How to Fictionally Carve Nature at its Joints.

> Numquam ponenda est pluralitas sine necessitate.
> William of Ockham, *Quaestiones et decisiones in quattuor libros Sententiarum Petri Lombardi*

In chapter 4 I argued against boundaries. Assume for the sake of simplicity that those arguments were compelling. According to § 2.6.3 and § 2.6.4, things depend upon boundaries. Thus, things do not exist insofar as there are no boundaries in the world. We then have to deeply revise our conception of the world. In a boundaryless world we cannot meaningfully speak about tables, rocks, or even about persons, as I showed in § 2.6.3 and § 2.6.4.

But that is just half of the story. Indeed, the arguments in chapter 4 are directed only against spatial boundaries, i.e. boundaries there are in space as things: there are no spatial boundaries since they fail to be things, and space can host only things. But that does not entail that there are no boundaries at all. And since we employ boundaries any time we describe space, they have to be somewhere else: what I claim is that the boundaries there are supposed to be in space are instead in our conventions, representations and perceptions of space. And we project such boundaries onto space. For instance, there is no genuine demarcation between Anglona and Romangia, but there is nevertheless a line that divides them. Strictly speaking, such a line is not in space, rather, it is in the geographical representation of it. Nonetheless, such a

line is located in a precise region of space although it is not there. That is, such a line is a feature of a representation of that region and not a feature of that region. The representation depicts space, adding some elements in order to reach certain human aims. In the case of Anglona and Romangia, the line between them has social and political aims. That boundary depends upon human beings' deliberate act and it does not literally belong to external world. Let us consider another example. The surface of a table is not a smooth continuous layer, as we usually think; instead, as physics teaches us, «all there is are smudgy bunches of handrons and leptons» (Varzi 2011b: 136), and speaking of a surface is as meaningless as speaking of a flat top of a fakir's bed of nails (Simons 1991: 91). The boundary we perceive in that is the result of a *fiat* act by means of our perceptual apparatus. If the argument in chapter 4 was compelling, then the same goes for every boundary: the surface of my body, the limit of a carpet, and so forth. My body does not have a boundary that divides it from its surroundings. Nevertheless, I act as if I have such boundary, since I mentally and socially represent my body as having a border. Moreover, I identify a quite precise region where that border lies.

Some of the boundaries that depend on human beings are the outcome of deliberate political or social acts. Others are products of non-deliberate acts: the horizon is a product of the cognitive structure of human beings, although it is not created in deliberative way but instead is due to an automatism (Smith 2001: 133).

Thus, since there are no boundaries at all in space, we can say that the boundaries we suppose to belong to things are instead features of our deliberate or non-deliberate representations of the things[128]. But we

[128] It is worth noting that, in general, *fiat* entities do not belong just to our representation, but also to our non-representational mental states, conventions, and so

commit the well-known representational fallacy of attributing to the world some of the features of our representation of it (Russell 1923). In fact, we usually think of boundaries as parts of the furniture of space; rather, they are parts of our representations of it. That is, there are no *bona fide* boundaries; there exist only *fiat* boundaries. Roughly, a *bona fide* boundary is a boundary that belongs to the furniture of space, whereas a *fiat* boundary is a boundary that belongs to our representation of space, and we nevertheless make believe that such a boundary belongs to space (Varzi 2013).

The dichotomy between *bona fide* boundary and *fiat* boundary was first introduced by Barry Smith in his (1997) and further refined in his (2001). However, the idea can be traced back to Stroll (1988: 183-212) who set up a «geometry of ordinary speech». That dichotomy was then employed for solving the problem of contact by Smith and Varzi (2001). In recent years, the dichotomy has again been employed by Varzi (2010, 2011b) as a basis for his general metaphysical picture. He argues that reality is unstructured and that it lacks *bona fide* joints. Although there are some boundaries, these boundaries are of the *fiat* sort. He calls his view "Humean fictionalism" (Varzi 2013) and he describes reality using the Quinean metaphor of desert (Varzi 2014): a world of just stuff that lacks any *bona fide* boundary.

By means of *fiat* boundaries, we pick things out of space, fictionally demarcating them from the environment. And so "things" can survive in our metaphysics, although only things that are dependent upon our representations. We need here a step more. Since we employ the words for our various boundaries as having references in the world and since we antirealist philosophers know that they are not in space, we need to

forth. For the sake of exposition, let us say that "representation" is here to be understood as a general term stand for every human talk about space.

assume a fictional approach to that issue: we need a system of make-believe about boundaries, and, thus, about things. Things and boundaries are then fictions "in" space: they do not exist in space, but we pretend they do. I call that thesis Spatial Fictionalism (SF).

As noted in the introduction, SF is the conjunction of three claims:

(a) *Dependence on Boundaries*: things derive their individuality from their boundaries: speaking of things without boundaries is meaningless.

(b) *Fiat Boundaries*: every boundary is of the *fiat* sort.

(c) *Stuffism*: stuff is of the *bona fide* sort.

I have already argued for point (a) in sections 2.6.3 and 2.6.4. The doctrine claims that things exist iff they are enclosed by means of boundaries. Otherwise, it turns out to be impossible to distinguish a thing from its complement. It is straightforward that since every boundary is of the *fiat* sort, every thing is thus drawn out of our representation.

Point (c) is Stuffism, namely the well-known doctrine according to which what exists is not a collection of disparate entities, but only undivided, yet heterogeneous stuff[129] (Heller 1990; Sidelle 1998; Dasgupta 2009). Stuff is usually understood as unindividuated reality, namely, a cohesive pile of properties not divided into discrete things. A world of stuff is a world with highly local variability, although to such variations there do not correspond discrete things.

[129] Describing stuff is beyond the aims of the dissertation. See, *inter alia*, Markosian 2015 and Lewowicz and Lombardi 2013.

Stuffism is needed in order to avoid the possibility that the conjunction of the first two doctrines might entail idealism, i.e. roughly, the doctrine according to which the totality of reality is a human thought (Guyer and Horstmann 2015) or irrealism, i.e. roughly, the doctrine according to which reality is just the representations of it (Goodman 1978). Instead, as Devitt (1991:17) remarks, stuffism is a form of «weak or fig-leaf [ontological] realism», namely, it only requires that something exists independently of human beings.

I guess that if you accept the arguments of chapter, 4 you should also accept either stuffism or nihilism, i.e. the doctrine according to which there are only simples, i.e. partless things. Indeed, if one assumes the existence of "non-structured something" beyond human representations and also denies the existence of boundaries, then such a something may be either a collection of partless things, since they are, by definition, without boundaries, or stuff, since that is also, by definition, boundaryless.

I prefer stuffism to nihilism insofar as it is not committed to a particular description of the fundamental reality. Namely, it does not entail that space is either made out of simples or is atomless gunk. Stuffism, according to this definition, is more general than nihilism and, thus, it may be compatible with it.

I turn now to point (b) which concerns what *fiat* boundaries are.

Let me first say that, in general, I suspect that the distinction between *bona fide* and *fiat* boundaries sheds a new light on:

(i) the debate about realism and antirealism. A theory of *fiat* boundaries interprets metaphysical realism as the doctrine according to which there are *bona fide* boundaries and metaphysical antirealism as the doctrine that there is no such

kind of boundary (Varzi 2013, 2014). This kind of metaphysical antirealism can be combined with a robust ontological realism about the existence of something beyond our representation, that is the content of our representation without boundaries: stuff. Let me stress again that that is equivalent to what Devitt (1991) calls weak realism.

(ii) the artifact/natural things distinction. The theory assigns the status of artifact, i.e. a thing with an author, to a wider class of things than the standard view usually does. In fact, if a thing depends upon its boundary and we human beings are authors of that boundary, then, in addition, that thing is a creation of one of our acts. Nonetheless, there is still a difference between a tree and a table. I set up that difference later in the chapter.

(iii) the epistemological status of human dependent things. The received view about human dependence stated by Searle 1995 (but see also Thomasson 2003), claims that if a thing depends upon human beings, then the knowledge about that thing (a) lacks errors or omission for at least its author and (b) may be total, i.e. the author may, in principle, know every detail about that thing. Within a theory of *fiat* boundaries both principles are to be dropped.

The plan of this chapter is as follows. In the first part, I expose the distinction and the characterization of *bona fide* and *fiat* boundaries. I then develop in detail a theory of *fiat* boundaries, i.e. an account of the exact meaning of "*fiat.*" More specifically, I outline: (i) how *fiat* boundaries depend upon human beings and (ii) how *fiat* boundaries are

created by means of a *fiat* act. Moreover, I classify different kinds of *fiat* boundaries. Indeed, to take one example, although the border of a nation and the surface of a tree are both of *fiat* sort, there are some modal and ontological differences between them.

Eventually, I outline the relation among "boundaryless" language and ordinary speech about bounded things.

The final picture is a world that does not have natural joints, but, rather, joints that are imposed by our representation of it.

5.1 *Bona Fide* and *Fiat* Boundaries.

As noted in the aforementioned literature, a *bona fide* boundary is a boundary that belongs to the furniture of the world, whereas a *fiat* boundary is a boundary that owes its existence to our ways of representing, conceptualizing, describing, and perceiving space. In other terms, a *bona fide* boundary is human independent and a *fiat* boundary is human dependent. Even if the boundary of a thing is of the *fiat* sort, this does not entail that the whole thing is *fiat*. Let us take an arbitrary portion of space. Since such a portion is an individual, it has a boundary that demarcates it from its complement. Such a boundary allows us to speak about "this" portion, otherwise it turns out to be impossible to discern the thing from its surroundings and, thus, it would not exist as individual. The boundary that demarcates it may be either *bona fide* or *fiat*. In the first case, it is a human independent thing that exists regardless the existence of humans. In the second case, it is a human dependent thing for what concerns its individuality and it exists iff at least one human being represents it. *Repetita iuvant*: the content of the demarcated region is human independent regardless of the status of its boundary. Clearly, that content may be identified as a thing merely

because it is demarcated by a boundary. Thus, it may be said that the thing is, on the one hand, authentically human independent, but, on the other hand, human dependent.

Moreover, a *bona fide* boundary is a discontinuity in space that marks, and according to 2.6.3 and 2.6.4 also makes, the difference between two discrete things. Whereas, a *fiat* boundary is not necessarily a discontinuity in space. It can also arise where there is no heterogeneity between two relevant things, e.g. between two administrative areas. A *fiat* boundary is a human projection of a discontinuity in space: it does not matter whether such a *fiat* boundary corresponds to a discontinuity that takes up space, insofar as the status of boundary is attributed to some humans' act. Consider a wall between two fields each of which has a different owner. The wall is the demarcation of the two mutually exclusive properties. Nevertheless, the status of boundary is attributed to the wall by certain laws and ascriptions, namely by certain humans' acts. In fact, it is admissible that certain private property has a wall that divides it into two halves and nevertheless that wall is not the boundary of two discrete properties.

The difference between the two kinds of boundaries is, thus, twofold, since it regards on the one hand, the relation between things and human beings and, on the other hand, the relation between boundary and boundary marker. Therefore, we have two *criteria* for distinguishing *bona fide* boundaries from *fiat* boundaries.

Furthermore, as noted in section 2.3 and in chapter 3, a boundary should be causally efficacious. It has to allow that every operation which it undergoes was inherited also by the whole thing it bounds. And it has the primary aim of allowing contact between two discrete things. Clearly, a *fiat* boundary cannot be causally efficacious since it is not strictly

speaking in space. Whereas a *bona fide* boundary is supposed to be in space and, thus, it has to be connected in causal chains.

Thus, a *bona fide* boundary is just a boundary as described in chapter 2 and that behaves as a thing in space with its three specific tasks: to bound a thing in order to distinguish it from its complement, to causally interact with other things in space on the behalf of the whole thing, and to allow contact. Whereas a *fiat* boundary, is a representation that we pretend it behaves as a boundary in space.

We can explain the difference between *bona fide* and *fiat* boundaries in a nutshell by saying that there are three criteria for distinguishing between them:

Human Dependence criterion (DC): *bona fide* boundaries are human independent, whereas *fiat* boundaries are human dependent.

Heterogeneity criterion (HC): a *bona fide* boundary occupies and is located in space, whereas a *fiat* boundary is only located in space, that is a *bona fide* boundary has to correspond to a heterogeneity in reality, a *fiat* boundary may or may not correspond to a discontinuity in space.

Causal criterion (CC): a *bona fide* boundary has to be causally efficacious.

I already explained the sense of CC in section 2.3 and even in chapter 3, since touching has to be part of a causal chain. Let me just remark that I do not hereafter assume that every thing in space has to be causally efficacious, but only what I have already said: a boundary has to be causally efficacious, otherwise it would lose some of its peculiarities. At any rate, the reader may not accept CC and, nevertheless, he may accept

only DC and HC. The three criteria are quite independent, although usually things which occupy space are also causally efficacious and human independent. I thus drop CC here, and I concentrate only on DC and HC. And, as I show later, DC and HC are deeply related. Let now assume the following definition of *fiat* things without CC:

> *Fiat* Boundaries: x is a *fiat* boundary iff (i) it is a boundary and (ii) it necessarily is human dependent and (iii) it possibly does not correspond to any discontinuity in space.

The point (i) is the straightforward clause that has to avoid the possibility that every arbitrary amount of stuff can count as a boundary even when it does not have the features listed in chapter 2. The clause (ii) is HD and the clause (iii) is HC. From that definition we can also obtain the notion of *bona fide* boundary.

> *Bona fide* Boundaries: x is a *bona fide* boundary iff (i) it is a boundary and (ii) it necessarily is not human dependent and (iii) it necessarily corresponds to a discontinuity in space.

The clause (i) is trivial as in the other definition. The clause (ii) states that a bona fide boundary does not have to depend on human beings for its existence. The clause (iii) states that it corresponds to a discontinuity in space, since it has to make the difference between a thing and its complement, as in the definition in chapter 2.

5.1.1 Human Dependence.

A *bona fide* boundary is a boundary that exists regardless of human beings, but not in a causal, nomological or physical sense. For instance, if the arguments in chapter 4 fail to be valid, then tables have boundaries, i.e. their outermost surfaces[130]. In a way, these boundaries are surely causally[131] human dependent since they are made by a carpenter. Thus, they depend on the existence of human beings. Nevertheless, once they are made, they continue to exist even if every human being ceases to exist. Therefore, in a way they are not human dependent.

Consider now the boundary between Anglona and Romangia. In the region between them there is no spatial discontinuity, no barrier or natural or artefactual border. Nevertheless, there is a line in the representations of that region, e.g. maps, treatises. That line is the boundary between them.

That boundary is made by human beings, without manipulating material reality, i.e. without an interference in a spatial causal chain. Such a boundary exists only in so far as the local community or local treaties recognize it. It is in a representation of a world, namely in a treatise among nations. It is in this sense human dependent. Boundaries like that are what the aforementioned literature calls *fiat* boundaries.

We already have notions of dependences, namely, the ones I stated in § 2.6.1; we now need the necessary and jointly sufficient conditions for a dependence relation being a human dependence relation.

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[130] "Outermost" since it is at least possible that a thing is made of a continuous series of layers and that it has more than one surface, yet just one external.

[131] For the sake of simplicity, I employ here a counterfactual analysis of causation, as assumed and explained in § 2.4. Nonetheless, I think that even a different analysis of causation may be successfully employed and the argument goes on anyway.

The classic treatment of this kind of human dependence was developed by Searle (1995: 156).

HDS (human dependence according to Searle): Necessarily, x is human dependent iff it is *a priori* dependent on human beings.

HDS, as Thomasson (2003: 581) explains it, means that the very concept of the dependent thing presupposes a shared agreement about what counts as that thing, namely there is a previous concept of that thing by means of which the identity criteria and the persistence conditions of that thing are set up. For instance, the existence of a boundary depends on an agreement among people about what can count as a boundary. Hence, a line on a map is a boundary since there is a convention among people that states that a line is a boundary[132].

HDS is usually employed for the so-called social objects or institutions, suchas moneys, cocktail parties, and so forth. Is it also useful for our purposes?

As Borghini (2014) claims, not every *fiat* boundary responds to such kind of *a priori* dependence. In fact, consider[133] a dancer who is playing *The Nutcracker*. She has to follow a precise script: with which foot to start, how to move on the stage, how to interact with other dancers, how to sway to the music, and so forth. Such a dance has a spatial beginning and end[134]. Moreover, the body of the dancer occupies a certain volume

[132] There are at least other two important versions of human dependence. Putnam (1981) argues that things depend upon concepts. Ferraris (2009) argues that things depend upon ascriptions. For the sake of argument, the differences among these three kinds of HC are not relevant. Furthermore, such characterizations are too narrow, since they do not regard perceptions, non-conceptual and non-propositional thought.

[133] I owe the following example to Borghini, who told me about it in a private communication.

[134] It has also a temporal beginning and end, but that is beyond the aims of the dissertation. See Borghini and Varzi 2006.

of space during the dance. Even that volume has some boundaries. We have then a situation like this: the body of a dancer occupies within an interval of time a certain volume of space with her dance. The volume of such dance has certain boundaries that determine whether that dance is correctly performed, since there is a previous scheme that states how that dance has to be performed. Nevertheless, the correct performance of the ballet can be evaluated only at the final stage. Moreover, since every stage is different, every stage presupposes a different performance of the same ballet[135]. Thus, there is no *a priori* correspondence to the right boundary of a dance and the rules that state how that dance should be performed. The correspondence can be evaluated only *a posteriori* since it is drawn in space by means of the performance only after it is conventionally fixed by the script. Indeed, its identity criteria and its persistence conditions arise only when the performance is concluded. There are clearly some rules to follow, i.e. the script, but since every performance is unique and every performance is fixed by the same script, we can evaluate whether the performance corresponds to the script only once the performance itself is played.

The same can be said for many spatial *fiat* boundaries. What I claim is that *a priori* dependence is too narrow constraint on general human dependence. Consider the following argument:

1. Boundaries of a dance are drawn *a posteriori* (A).
2. *Fiat* boundaries are drawn *a priori* (HDS).
3. Boundaries of a dance are not of the *fiat* sort (from 1 and 2).

[135] See Goodman 1968, who distinguishes between allographic arts, i.e. arts whose artworks can be instantiated at different times following a script, and autographic arts, i.e. arts whose instantiations cannot be reproduced more than one time.

The conclusion 3 is at odds with the definition of *fiat* and *bona fide* boundaries. The definition claims that a *fiat* boundary possibly does not correspond to any spatial discontinuity. In the case of a dance, there is a boundary and no spatial discontinuity. Thus, either there is no boundary, and that is contradictory with the assumption that a dance has a boundary, or it is *bona fide*, but that contradicts the notion that a *bona fide* boundary must correspond to a discontinuity in space. If we accept that there is a boundary of a dance and that boundary is of the *fiat* sort, then we have to reject HDS.

Thus, the first point against HDS is that a human dependent thing does not necessarily depend on human beings *a priori*.

Furthermore, there is a second reason why HDS is not a good characterization of human dependence. HDS states that since a dependent thing depends on an agreement, such dependence has to be deliberative, i.e. human beings should know what things depend on them. If a thing depends on human beings, then such dependence has to be conscious and voluntary, namely: that thing has to be known by the person or people that necessitate such thing and that thing has to be voluntary accepted as a thing. That position has two corollaries:

1. Human beings always know what they necessitate;
2. Human beings choose what they necessitate.

The study of boundary teaches us that the two corollaries contravene some other intuitions.

Consider the first corollary. It is easily provable: since every dependent thing is the outcome of an agreement and an agreement presupposes, by definition, knowledge of it, every dependent thing is

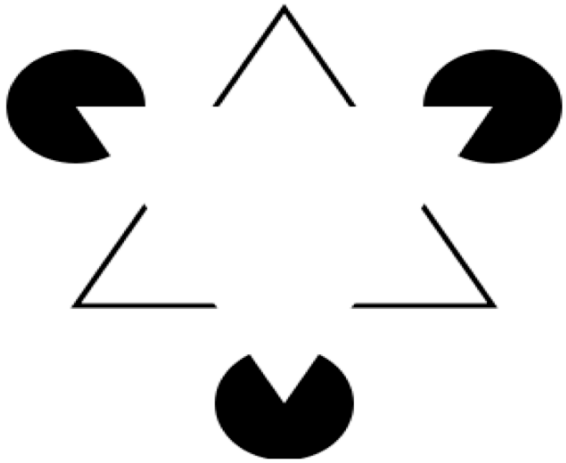
known. I add «always» since a definition has to be trivially known over every instant of time of which it is known.

Consider the boundary of Gennargentu and the valley around. The distinction between the two may be considered as human dependent, if the arguments in chapter 4 work. In this case it seems that the first corollary is false: not everyone is aware that the distinction between the two is human dependent. Clearly, a supporter of SHD can rebut, saying that there are some people that know that the boundary between Gennargentu and the valley is human dependent. Nevertheless, it seems that even people aware of it lack the knowledge about where the boundary is. That is, such boundary is not a place in a precise region, rather it is vague, and it is unlikely that there will be a convention that fixes precisely where such boundary should be located. Even if such location was fixed by a convention, it would turn out to be *a posteriori* in respect of the boundary itself. Perhaps it is fixed according to certain empirical evidences and, thus, not on the basis of purely *a priori* facts. Thus, it cannot be said that people always know what they necessitate. Recall the example of dance: in that case, the boundaries are clearly of the *fiat* sort and, nevertheless, they are fixed *a posteriori*.

Consider now the second corollary. It says that people are aware of what they necessitate. For instance, when a national border is fixed, there is an agreement among politicians and, thus, politicians are aware that they are stipulating an agreement.

Nevertheless, such awareness about dependence cannot be not generalizable. Consider the famous Kanizsa Triangle. We see in the picture two triangles. We correctly see the boundary of one of the two since it has a black perimeter. But we illusorily see the boundary of the other one although it has no a drawn perimeter. We know that this second perimeter is the product of our perceptual system and, thus, such

boundary is not in space. Nonetheless, we cannot choose to move that boundary to a new region by an agreement or by another act.



Furthermore, we cannot decide anything about the nature of such boundary *a priori*, since it is an effect of our way of perceiving the world. This is also true of a wide range of boundaries.

Consider the boundary between the zone inhabited by Catholics and the one inhabited by Protestants in Belfast. That boundary is clearly *fiat*, since there is no discontinuity in space that marks it. And it is not chosen since it is the value of a function that calculates the progressive decrease in one population[136].

Since SHD suffers from all these problems, we need a new characterization of human dependence. I propose the following one:

HD: Necessarily, x is human dependent iff necessarily, its location is fixed by a *fiat* act.

[136] The example is inspired by Thomasson 2001.

HD states that a given thing depends upon human beings if its location, i.e. the region or the sum of the regions it occupies, is fixed in every possible world by a *fiat* act[137]. For instance, the location of the boundary of a table is fixed by our not so fine grained sight, that is, it fixes the boundary of the table where it perceives the difference between the table itself and its surroundings, although there is no such difference.

A further clarification is needed of the right-hand side of the biconditional. First, the reason for the modal strength. Second, what «*fiat* act» means.

The modal strength is important here since it rules out the possibility that the location of a thing is fixed by non-human factors. For instance, assume there are boundaries and consider a table: its location can be fixed not only by my act, but even by some non-human event, such as a high wind. Thus, the location of a table is not human dependent.

Let us now consider the notion of *fiat* act. That notion was already employed by Smith in his works on *fiat* entities. Unfortunately, he did not explain what he meant. He said only that a *fiat* act is an human act. But manufacturing a table is also a human act, but it is clearly different from what we need in this context. Indeed, we have to rule out every attempt to identify every human act with the *fiat* ones because in that case, the notion would collapse in the broadest one of human act. Furthermore, as noted at the very beginning of the paragraph, we are speaking about something that is not causal in space and some human acts are so.

A *fiat* act may be either a primitive notion that denotes every act that is human and non- causal in space, or a complex notion liable to analysis.

[137] See also Haslanger 2012.

I give up the first possibility, since even if it seems difficult to find a suitable definition of *fiat* act, I think there is at least a resemblance among the various kinds of acts it denotes.

Such acts, as I explain more fully later in this chapter, are:

- perceptual, e.g. the boundary of a figure against a ground.
- linguistic, e.g. grouping discrete things in a single thing, such as cows in a flock.
- conventional, e.g. the border of a nation.
- conceptual, e.g. a kiss that is singled out as a continuous event by the concept «kiss».
- proprioceptional, e.g. the position of the body in space.

Each of the above acts has something in common, namely, they are projected onto space even though they are not in space, that is, they do not correspond to a spatial discontinuity. They confer a special status to a qualified content of a region of space without having any causal relation with it. For instance, a *fiat* linguistic act confers the status of boundary to an imaginary line that groups together a flock. Thus, a *fiat* act can be defined as an human act that confers on some stuff a role, without any causal interaction with it.

It is straightforward that a *bona fide* boundary is a boundary whose location in space depends upon some causal or nomological fact.

5.1.2 *Fiat* Acts and non-heterogeneity.

As noted, a *fiat* act confers a special status on some stuff without any causal or nomological interaction with it. Moreover, I also show that a purely *a priori* approach is to narrow and it does not include some cases,

such as perceptions or actions. What is then to confer a special status on some stuff? What is the act which confers that status? The problem is to understand what confers on a certain hunk of stuff the particular status of boundary. That is, what I called a *fiat* act.

Let us begin with the received view of such kinds of acts, proposed by Searle (1995). He states the following rule:

«x counts as y in c»

This means that a certain thing counts as a certain other thing within a context. For instance, a certain region of space counts as the boundary between two nations within the context of an international treaty.

As stressed above, Searle and his acolytes think that such status is conferred by that act because there is a collective intention. Ferraris (2009) holds that such status is conferred by ascriptions. In general, the received view assumes that the conferred status originates from an agreement, namely, a deliberative collective act[138]. As I have already argued, such a claim rules out some important *fiat* acts, such as the individual ones and the non-deliberative ones. I want, then, a broader criterion that also includes those two kinds of act. In other words: we need a comprehensive notion of *fiat* act. I think the following one may be a good solution:

Fiat Act: x is a *fiat* act iff (i) it is a human act; (ii) it is not causally efficacious in space; (iii) it is causally efficacious in a representation of space.

[138] There are some who disagree. See, *inter alia*, Sveinsdóttir 2015.

The clause (i) states that a *fiat* act is a human act. It rules out the possibility that certain beasts' acts may be included here. The clause (ii) stipulates that such an act does not have any causal efficacy in space; otherwise such a definition would also include acts such as manufacturing or other human acts that are rather causally efficacious in space. The last clause rules out from the list of possible acts the pure imaginative ones, such as creating a fictional character in a novel or proving a theorem[139] since it refers to representations of space.

One can argue that a fictional character may be in a certain representation of space, e.g. Sherlock Holmes was located in the representation of London. Therefore, such a definition of *fiat* act also includes the act of creating a novel. I need to rule out such a possibility since I think the representation of space in a novel and the representation of space as assumed in the definition – henceforth refered to as RS – have very different features. I suppose that the features are to be tracked down in the reasons why they come into being, in consistency with some non- human dependent laws, and in the components of representations.

Indeed, an RS has among its motivations some pragmatic aims. In fact, the representation has to be helpful for a human activity. A novel may be helpful for human beings, but it also may not be so. Whereas, an RS has to be helpful as a matter of necessity. Clearly, it may fail at such a task but nevertheless it posits the task among its reasons.

Moreover, an RS has to follow not only its internal rules and human dependent rules. It also has to respect some human independent laws and some human independent facts. For instance, the perceptual representation of the boundary of a table has to follow the physical laws

[139] I do not assume here any ontological thesis about the nature of mathematical entities. I just assume that such entities are located outside space and time.

that govern the refraction of light. Whereas a table within a novel may not follow such laws. Consider a map: the position of the shoreline is clearly posited by a *fiat* act, since there is not a thing like that in space: a shoreline has not a precise position due to the movements of the sea. Nevertheless, its position is calculated within an interval and the media of that interval is the location drawn on the map. Thus, it is not in space but it follows some laws that are not human dependent.

Eventually, RS has to include representations of *bona fide* reality among its components. My perceptual representation of the table includes, beyond *fiat* boundaries, an amount of wood-stuff, which is *bona fide*. The map of an island represents the stuff of which the island is made and not only its *fiat* boundaries. Rather, a novel may clearly include among its components representations of *bona fide* reality, but it does not have to include them as a matter of necessity. A novel set outside space and time may be very nice.

Hence, an RS has to have three features that differentiate it from a general representation:

- pragmatic reasons.
- consistency with human independent rules.
- representations of some *bona fide* components.

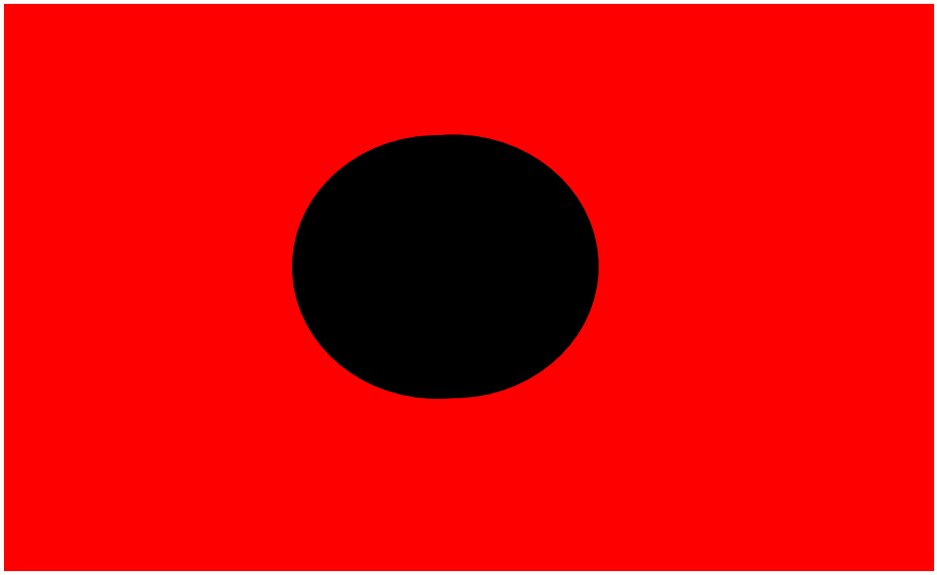
The moral is that a portion of stuff is appointed by the status of *fiat* boundary by means of a *fiat* act. In other words: a *fiat* boundary is an outcome of a *fiat* act.

Paraphrasing a well-known expression, *fiat* acts fictionally carve nature at its joints. How? Let us consider a chunk of stuff and suppose we want to use it as a boundary for a certain portion of reality. We merely need to represent it through a medium as a boundary. It is exactly what

we do every day when we mentally divide the room into two halves, or when we perceive the outermost surface of a wall, or when we draw a line on a map. It seems that these boundaries I mentioned are somehow different.

5.2 Taxonomies of *Fiat* Boundaries.

Although *fiat* boundaries all belong to the same kind, there are some differences among them. For instance, the boundaries created by our perception of the world are surely different from the boundaries produced by our conventions. Surely, there are cases in which some boundaries are both products of perception and conventions. Consider the case of a black hole against a red ground, as in the picture below.



The hole has as a boundary its perimeter. We perceive the boundary because our sight distinguishes two different refractions of light. Thus, the boundary depends on our perceptions of colors and figures. Nevertheless, our perception is silent on the owner of the boundary.

According to a seemingly natural intuition, the ground is the owner of the perimeter of a hole, since a hole is immaterial. Suppose the ground turns into black and the hole into red. In that case, who is the owner of the boundary? It seems natural to answer, "the ground," even though there are no significant differences between the case we are now imagining and the previous case but the color. And it seems an obvious assumption that every difference must have a sufficient reason. Thus, since there are no differences and, nevertheless, the boundary in each of the two cases has a different owner, such asymmetry has to be tracked down in a widespread convention that claims that a hole does not own its perimeter, whereas a circle does.

I have already proposed a classification of boundaries in § 5.1.1, based on their origins: perception, language, convention, concept, prioception. I think there are at least other three more possible taxonomies. Let me list them:

- Deliberative / non-deliberative.
- individual / collective.
- a priori / a posteriori.

Each of the above taxonomies is based on a different criterion and each of them can be combined with the other in more than one way. I do not set forth a list of boundaries according to each criterion, since the list would be partial and not definitive. Rather, I explain how each criterion works and leave the reader free to list his favorite boundaries.

5.2.1 Deliberative and Non-Deliberative Boundaries.

The first alternative is to list boundaries in a taxonomy that consider the relations they have with the awareness of the human beings who produce them. Indeed, some boundaries are created by a deliberative *fiat* act, e.g. national borders, whereas there are some boundaries that do not depend on a deliberative act but, instead, are an outcome of a non-deliberative act. Consider the already mentioned illusory triangles by Kanizsa: illusory boundaries are there since our perception represents them in such a region, even though that representation is not an outcome of a deliberative act, but rather is imposed by the structure of our perception itself. We do not choose where such a boundary lies but nevertheless the region in which it lies depends upon us. We cannot change the region they occupy, and, nevertheless, their position in space depends upon us.

There are other interesting cases of non-deliberative boundaries that are not related to perception. Consider again the case of the boundary between Catholics and Protestants in the city of Belfast in 2001.

Such boundaries depend upon human beings and so does their position in space. Nevertheless, such dependence is non-deliberative for their regions are not explicitly chosen by human beings. In fact, the lines that divide the areas inhabited by Catholics from the areas inhabited by Protestants are clearly dependent upon a *fiat* act: the act of drawing lines on maps based on (i) certain technical competences; (ii) certain beliefs. And, thus, we necessitate where the line has to lie and nevertheless we do not necessitate it in a deliberate way. In other words, the line is there due to us but we cannot choose where the line has to be located.

We can then define the non-deliberative and deliberative boundaries according to the following definition:

A *fiat* boundary is a deliberative boundary iff it depends upon a deliberative *fiat* act.

By "deliberative *fiat* act" I mean a *fiat* act that is explicitly chosen by a human being. It is surely difficult to distinguish deliberative and non-deliberative acts. Nevertheless, there are certain patent cases, such as perception, which is non –deliberative and social convention, which is deliberative since it needs an explicit or implicit agreement.

To sum up, a *fiat* boundary may be either deliberative, or non-deliberative based on the awareness of the human being that set it up.

5.2.2 Individual and Collective Boundaries.

The second way to list boundaries is on the basis of how many people are committed to the *fiat* act that produces such boundaries. Consider the case of a purely mental division of a room in sections in prevision of

a new design of the room itself. Someone who mentally divides the room traces some boundaries in space according to the future disposition of the furniture. In this case the boundaries are clearly individual in the relevant sense, since just one person is committed to them and just one person acts to create them.

Now consider the case of national borders . In this case, there are many people committed to both their creation and their existence: politicians, geographers, common people. Indeed, many people are needed in order for such boundaries to exist.

There are also cases that are difficult to classify within the dichotomy. Consider the boundaries projected by our sight into the world, for instance, the boundary of a table. Arguably, every human being projects the same boundary in the same region and, nevertheless, this act is not shared with others as in the case of national borders.

To solve the problem, I propose to classify that boundary on the basis of the agreement among people necessary for the existence of such boundary. In fact, arguably the boundary of a table needs just one person who perceives it, whereas the boundary of a nation needs at least two persons who agree about it. Then, we can classify such boundaries using the following definition that we can use alternatively as criteria for the taxonomy:

x is an individual boundary iff there is only one person committed to it.

x is a collective boundary iff there are more than one person committed to it.

Clearly, there are still problematic cases, but the two definitions can be usefully employed in many situations.

5.2.3 A Priori and A Posteriori Boundaries.

As stressed in § 5.1.1, not every boundary is drawn a priori, as concepts or also some conventions are. There are some boundaries that are *fiat* and nevertheless are drawn just after having experience of them.

Consider the example proposed by Borghini (2014) of cutting meat in the religious context of Hebraism. The *menakker*, i.e. the butcher expert in *kosher* tradition, has to cut the meat according to certain holy rules. Such cutting, called *nikkur*, has to divide the parts of the beast that can be eaten from the forbidden parts. If the *menakker* does the wrong cut the whole piece of meat has to be discarded. His job consists in cutting the beast following certain rules, drawing with the knife the line that takes apart the allowed parts from the forbidden ones. Beyond the difficulty of the task, Borghini rightly claims that the outcome of the operation can be evaluated only once the cutting is done. That is, the boundary between the allowed parts and the forbidden ones arises only once the boundary itself is drawn by means of the knife. It means that such a boundary is not a priori since it is drawn during the experience. Consider by contrast the boundary of a nation, for instance, the boundary between Italy and France at Mont Blanc. Such a boundary is located in a certain region and it remains there despite the fact such region changes as a result of avalanches and melting. Whereas, the boundary between the right and the wrong, as in the case of *nikkur*, can be tracked down only once it is carried out.

Clearly, there are often mixed boundaries, as in this case. Nevertheless, such a distinction can be useful employed for

understanding what actions have their roots in experience and what actions have their roots in concepts.

PART 3.

APPLICATIONS.

6. Urban Planning and *Fiat* Boundaries.

> "One calls the equator an imaginary line, but it would be wrong to call it a line that has merely been thought up. It was not created by thought as the result of a psychological process, but is only apprehended or grasped by thought. If its being apprehended were a matter of its coming into being, then we could not say anything positive about the equator for any time prior to this supposed coming into being."
>
> Gottlob Frege, ***The Foundations of Arithmetic***

The theory of *fiat* boundary is deeply related to the theory of urban planning. I claim that drawing boundaries is one of the central task of the activity of planning and hence its study should be one of the central issue of the theory of urban planning. In order to appreciate some centrality, consider few instances. Consider zoning: it is the activity of drawing boundaries in a representation of a territory in order to divide it according to certain aims. Consider the business of planning a region. Among different convergent practices, the planner should individuate the limit of her actions in space and time: how far and how long her action will have effect. That is, she has to literally either draw or individuate the boundary of her planning in time and space. Furthermore, consider a case in which a planner has to design a land use plan. She has to respect some administrative limits to her action, namely some preexisting

boundaries. The relation between urban planning and boundaries is thus threefold:

(i) it has to draw boundaries, i.e. it has to choose and sometimes mark the region which separates two other regions.
(ii) it has to individuate boundaries, i.e. it has to find the some preexisting relevant boundaries, e.g. administrative limits, biological borders and so forth.
(iii) it has to respect boundaries, i.e. it has to avoid that its action goes beyond the boundaries of the relevant area.

As I argued in chapter 4, since every boundary is of the *fiat* sort urban planning should have an interest in the theory of *fiat* boundaries. Moreover, even though one does not find compelling arguments in chapter 4, it is straightforward that there are cases in which urban planning has to confer the status of boundary to a certain amount of stuff. For instance, as Smith (2007) showed, in case in which a urban planner has to divide the public space from the Eruv, i.e. the zone in which orthodox Jews can carry out operations otherwise forbidden during the Sabbath, e.g. cooking, pushing prams, and so forth. Such zone may have no physical separation with its surrounding and nevertheless it enjoys special status. The boundaries between Eruv and its surrounding are not material and yet important for the Hebrew community. In cases like this, I think it is applicable the model of status conferment explained in chapter 5. In particular, boundaries of Eruv are both collective and deliberative.

Furthermore, urban planning need boundaries not just in practice, but also in its theory. Consider now the concept of landscape, one of the central theoretical issue in the discipline. It is usually defined as a piece

of territory as perceived from the local community[140]. Landscape is defined by the European Convention of Landscape at article 1, def. 1[141] as:

«an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors»

That definition entails as a corollary that landscape has boundaries. The corollary is simply provable. The definition due to the Convention – henceforth CL – set up an identity relation between the notion of landscape and the notion of area. An area in order to be so need a perimeter, that is its boundary. Then by the identity of indiscernible[142], they must have every property in common. Nevertheless, boundaries are not a property, but rather a part. That is not a problem, since the extension of an area is one of its property and the landscape that has to be identical to that area has to share every property of the area itself. In order to have a certain extension an area has to have boundary, otherwise it turns out to be impossible having an extension, as I argue in 2.6.2 and 2.6.3. Then even though landscape may not have boundary the area of which it is identical has to have them. And since they are identical also the landscape has to have boundaries.

I claim that such boundaries are of the *fiat* sort. Not only for arguments in chapter 4, but also for the very concept of landscape entails that the boundary of its referents are fictional. For instance, the definition by CL

[140] The definition is widespread among the theorist of landscape, for a survey see Bonesio 2007: 189-222. Nevertheless, the same expression is used within analytic environmental aesthetics as a synonymous of nature or wilderness, see inter alia Carlson 2016. I here assumed the convention according to which the label landscape is for the referent of the description in European Convention of Landscape. Whereas I use the label wilderness or nature for the narrower concept of non anthropized land.
[141] For a philosophical study on the convention see D'Angelo 2010: 147-152.
[142] See here 1.1.3 and 4.5.1.

set forth that the area that is identical to the landscape is the result of the interaction between human and natural factors. I will argue that the human factors consider fiat acts.

Here the plan of the chapter. I first show a new useful dichotomy about boundaries, namely a further more fine grained distinction about *fiat* boundaries. I then show three consequences of adopting the theory of *fiat* boundaries within urban planning theory: the problem of the end, i.e. where a plan has its boundaries; the problem of the owning, i.e. how to delimitate a property without *bona fide* boundaries. I eventually show why a coherent notion of landscape need a theory of *fiat* boundaries.

6.1 Strong and Weak *Fiat* Boundaries.

Despite of I claim that there are no *bona fide* boundaries at all, it seems that at the very end of the day some of them exist if not at the fundamental physical level, at least in the mesoscopic reality.

In fact, consider a wall. It has no boundaries according to chapter 4 and it cannot be a boundary of a thing. Nevertheless, two arbitrary amount of stuff can act as boundary of the wall, namely what we can call its last layers. The wall itself can act as a boundary, e.g. the boundary of a private field. Even the line drawn between Canada and USA acts as a boundary. In chapter 5 I explained why we adopt the convention according to which the wall and the administrative line are boundaries. Nonetheless, it seems that there is a difference between these two boundaries that is not explained in chapter 5: the wall but not the line is a part of a spatio-temporal causal chain. In fact, the wall can avoid thefts, it can prevent that dogs escape, it can be painful walk into it, it chemical reacts to rain and other weather phenomenon, and so forth. It seems a properly inhabitant of space since it is causally efficacious. It seems at

odd with our intuitions denying the existence of a thing that is causally effective.

Consider now an administrative line such as the border between USA and Canada. Such line can obstruct the actions of a law. Indeed, only an administrative division can stop the effects of certain law. For instance, the border between USA and Canada certifies the difference of policy about minor drugs. Clearly, a wall can be built where such line is drawn or such line can be drawn where there is a wall, but it is the line on a map that officially divide the two zones as noted in chapter 5, i.e. it is the line that confers the status of two different zones.

To sum up: there are boundaries that seem to be part of spatio-temporal causal chain and boundaries that seem to be part of social causal chains, regardless the nature of space.

It seems that the first belongs to *bona fide* sort and second to the *fiat* sort. There is really such kind of difference between the wall and line? I do not think so. I think we are in presence of another kind of distinction.

Before introducing the distinction let me arguing against the fact that some *bona fide* boundaries exist. Consider the wall. It suffers of all the problems list in chapter 4: it is vague (§ 4.1.), i.e. it is not possible to individuate which particle belong to it and which not; it is metaphysically arbitrary (§ 4.2), i.e. it is not possible to individuate its last part. It is also the possible source of the paradox of diachronic identity (§ 4.4) and the grounding problem (§ 4.5). Nevertheless, it seems to us that the wall is part of a causal chain. Perhaps, such arguments are valid only at the fundamental physical level and not to the mesoscopic level. We can deny the existence of the boundary of the wall, since they suffers all the problems listed, but not of the wall itself. Such belief entails a contradiction. The wall is made of a certain amount of stuff it is then it has a certain determinate volume. Unfortunately, since the wall has

neither an end, nor a start it is impossible distinguish it from its surrounding. Thus, either (i) its volume is the volume of the whole universe, or (ii) it has no volume.

The disjunct (i) is justified by the fact that since it is impossible to discern the wall from its surrounding it is because it is part of the surrounding itself since there is nothing that divide the wall from it. Thus, since it is also impossible distinguish from the various parts of the universe, just one thing has a volume, namely the whole universe itself. Therefore, the volume of the wall is the volume of the universe. Contradiction: the wall is not the universe.

The disjunct (ii) is entailed by the fact that since it is impossible distinguish the wall from its surrounding then there is no a thing as a wall with it volume. Therefore, the wall has no volume at all.

A thing without volume cannot be, by definition, efficacious in spatio-temporal realm and thus we have to give up the belief according to which the wall is causal effective. Thus, the wall does not exist.

The argument reaches the conclusion that since there are no boundaries at the fundamental level, there are also no boundaries at the mesoscopic level.

At most, we can say that a part of reality that we call "wall" is part of a causal chain. Although it is a *fiat* act that singles out such part of reality from its surrounding establishing that the contents of certain regions of space are its boundaries, i.e. its outermost layers, although we know that such operation is a *fiat* act. A further *fiat* act is the operation according to which we establish that the wall is the border of a field.

Nevertheless, boundaries such as a wall are necessary in certain context of utterance, for instance when we say, «the wall stopped the dogs». We have to correctly say that «an arbitrary content of a region of

space which we call “wall” interrupt the movement of some arbitrary contents of certain other regions of space which we call “dogs”».

I do not aim to find the right semantic for the theory of *fiat* boundaries[143], rather I want to find a way for distinguishing *fiat* boundaries within context of utterance. In fact, we want to distinguish the relevance of a wall when we speak on space-time from the less relevance of an administrative line and also the converse. Indeed, the role of a wall is stronger in a context of utterance about space than the role of an administrative line and nevertheless both may be features of a representation of the same portion of space. In the same and yet converse way, the role of the line is stronger in a context of international law than the role of a wall.

In order to stress such distinction, I propose a dichotomy between strong and weak boundaries. Where strong boundaries have the modal strength of *de dicto* necessity, whereas the weak boundaries have the modal strength of *de dicto* possibility. Such strength depends on the general context in which they are employed. More in details:

A *fiat* boundary so-and-so is a strong boundary iff it is necessary so-and-so in a context.

It means that within a context a boundary we assume or we speak about is necessarily as we describe it either according to the rules of the context, or in order to lead certain conclusion in a context. That is, in every possible world in which there is a counterpart of the causal event that involves some entities the labels of that entities necessarily have among their identity criteria all the relevant properties of that entities.

[143] For a critical survey of semantics for who denies the existence of things see Turner 2011.

For instance, within the context of spatio-temporal causation a wall that is a part of a causal chain necessarily owns as much property as the piece of stuff we label "wall" that stand in that causal chain. Otherwise, some of the properties that are involved in the causal chain are not considered in our utterance. Hence, the wall we speak about necessarily has the same weight, volume and charge of the piece of stuff we label "wall". And so on.

A *fiat* boundary so-and-so is a weak boundary iff it is possibly so-and-so in a context.

It means that within a context a boundary we assume or we speak about is possibly as we describe it. Within the context of international law a wall may be or may be not owner of all the physical property of the piece of stuff we label wall. Indeed, many of these properties are not necessarily within that context.

We have then two general kinds of fiat boundaries that distinguish them within a context just according to their modal strength in that context. I employ that distinction to solve many problems in this chapter.

6.2 On the Boundaries of a Plan.

Consider a situation like this: an urban planner assumes the tasks to design a certain piece of land. She has to divide it in zones, she has to establish the use of such zones, she has also to determine a certain plan of developments, and so on. Suppose such land is a city that is not enclosed by any strong boundary from its surrounding, such as mountains, rivers, and so forth. Suppose that the industrial zone of the city is located at its outermost region. In that zone, there are some

factories that produce polluting emissions. What the planner should do[144]? She has obviously to be worried about the effects of such pollutions within the boundaries of the city. Must she also be worried about the effects of such pollutions beyond the boundaries of the city she plans? It is worth noting that her possible actions have effects not only within the boundaries of the city but in the land around as well. In fact, the pollution goes beyond the land she has to design and such pollution could contaminate also the neighbor land. Perhaps the boundaries of her plan are not the boundaries of the city she plans. They are wider.

The most natural way to see that situation may lead to two different ways of drawing boundaries of the plan: either she draws the boundaries of the plan retracing the administrative boundaries of the city or she decide to draw elsewhere such boundaries, namely to where her plan has effects.

In the first case, she is responsible of just what she does within the preexisting administrative boundaries. In the second case, she is responsible of every effect of her planning. Hence, we have two different positions:

The first position – call it "static boundary position" (SBP) – claims that the actions of a planner are only the ones carried out within the boundary of the land she designs. In the case of the city, the effects of her actions she has to care about are the ones within the boundaries of the city.

The second position – call it "dynamic boundary position" (DBP) – claims that the actions of a planner draw new boundaries that are located at the end of every possible effects of her plan. In the case of the city, the

[144] A problem like this is discussed by Bacchini 2015 about architecture and its influence on future generations.

effects of the actions she has to care about are all the effects of her actions, regardless their distance to the boundaries of the city.

Supporters of both positions agree on the fact that effects of planning goes beyond the boundaries of the plan itself. Although, they disagree on the fact that a planner should plan or care about also that effects.

I claim that DBP can offer a better explanation of how a planner should act than SBP. Let me first expose in detail and present some arguments for SBP and then reject them. I eventually illustrate why DBP is more justified.

6.2.1 Static Boundaries Position.

A supporter of SBP claims that the only relevant actions of a planner are the ones within the boundaries of her plan and thus the only effects she has to plan or consider are the ones within such boundaries. Despite of she knows that the effects of the plan goes beyond such boundaries.

She can argue for SDP in three ways.

First, she can argue that the only relevant effects of her actions are the direct ones, namely the ones she wants to cause[145] in her plan. Hence, she has to care about only to such effects she has already considered in her plan. The effects of pollutions beyond the administrative boundaries of the city are not consider and in her plan and hence she does not care about them. Nevertheless, such argument suffers of a lethal counterexample. Suppose that a plan has an indirect effect within the boundaries of the city, e.g. the design of the city center yields congestion. It is not a desiderate or direct effects of her actions and nevertheless it is

[145] Assume again a counterfactual analysis of causation, as in the previous sections of this dissertation. See § 2.4.

caused by her actions. Now, either the supporter of SDP claims that the planner does not care about for that, or she has to care about.

Unless one supports the first disjunct, I believe there are no reasons to distinguish the indirect effects within the boundaries of the city form the ones beyond them. Thus, a planner should care about of both effects within and beyond the boundaries of the city.

Second, a supporter of SBP can argue that the only effects she has to care about are the ones that are predictable or knowable. Since she cannot know how far the pollution can arrive, she has to care about only of what she can know. She knows for sure that such pollution may be dangerous for the city and thus she has to care about only for the city. That argument suffers of two counterexamples. First, some of the effects within the city of her actions may be unknowable, e.g. she cannot consider every possible effect of her choice of certain material instead of another. Second, some of the effects of her actions that go beyond the boundaries of the city are predictable. And she has not to care about some effects within the city but she has to care about some effects beyond the city. It seems absurd.

Third, a supporter of SBP can argue that the administrative boundaries of a city are the strong boundaries of a plan, whereas the boundary to where her actions have effects are of the weak sort. Thus, since the first are necessary for her plan she has to care about only for them. There are at least two reasons for why such argument is defective. First, from the fact that the administrative boundaries of the city are the strong boundaries of the plan one cannot infer that they are the only boundaries she has to care about. There is no clear inference that links the two claims. Why should one care about only the strong boundaries and not about the weak ones?

Second and more important the strong boundaries of a plan are not the ones of the city she has to plan but rather they are the boundaries of its effects. That is the claim defended by supporters of DBP.

6.2.2 Dynamic Boundaries Position.

DBP claims that the boundaries of the plan coincide with the boundaries of the effects of such plan. Thus, a planner should care about not only for the effects of her actions within a land she has to plan but also for every effect she causes with her planning. That is, a plan of a zone is not the plan of every thing inside that zone but instead it is the plan of every thing is caused by her actions from that zone[146].

There are at least two arguments in support to that claim.

First, since a planner should care about the effects of actions beyond the boundaries by symmetry principle she should care about her actions beyond the boundaries of the land she has to plan. Assume that a plan should plan, as Blečić and Cecchini (2016) argue, the property of antifragility for its object: every external solicitation should be absorbed by the planned object in order to became stronger. A corollary of that claim is that a plan should consider both effects from outside and from inside the planned land. Otherwise, it cannot turn the planned object into an antifragile object, i.e. it cannot be ready to react to solicitations unless it considers also effects from the outside. Such claim does not entail that a plan should also care about its effects to the outside, nevertheless it can lead to the conclusion it owes to since a sort of symmetry principle. The symmetry principle I have in mind is the following:

[146] It is similar but not equivalent to the theory according to which urban plan are process. Namely the claim according to which plan has consider also its future effects. In fact, DBP claims that a plan has to consider also its effects beyond the boundaries of the land it designs.

Symmetry Principle: To every effect of a plan may correspond a counter effects that may react against the original cause of the effect.

It means that if a plan causes an effect beyond the boundaries of the planned object, such effect may interact, positively or negatively, with the planned object itself. Thus, if a planner want to avoid risks or if she want to increase benefits, then she has to consider also that effects. Should she also avoid that effect itself? It depends on the specific effect she has to analyze. In general, it entails that the boundary of a plan does not coincide to the boundary of the planned land since a plan should consider every possible events that may interact with the planned land even if such event happens beyond the boundaries of that land.

Second, a plan has its boundaries at least where it carries out its effects. This argument may be read in continuity with the first. In fact, if a planner want to consider every event that may be interact with the planned land, she has to broaden the boundaries of the plan, at least as far as its effects may be traced. Such boundaries may be also broader than that. Surely, they cannot be narrower.

Thus, without mentioning the interests of other lands beyond the one that is the center of the plan, we can arrive to the conclusion that also the effects outside the land a planner has to design have to be considered.

6.3 The Problem of the Property.

Consider these two stories:

(i) One side of the Alps belong to Italy. Nevertheless, the prime minister of Albania claims that such side belongs to Albania too, since every boundary is of the *fiat* sort[147]. Thus Italy cannot claim the right of property of this side of Alps.

(ii) You should find the boundary between two regions separated by a mountain range. Since every boundary is of the *fiat* sort there is anything that separate the two regions. Thus it is impossible to say what belongs to the first region and what to the second.

The stories has the same structure: there is what it seems a *bona fide* boundary but due to the theory of *fiat* boundaries we know that it is just a *fiat* boundary. Thus, without *bona fide* boundaries it is impossible to understand what belongs to what.

One may be lead to believe that the pragmatic cost of the theory is too hard. Thus, it may be convenient to came back to the old dichotomy *bona fide*/*fiat* boundaries. In a world that does not lack *bona fide* boundaries recognizing a property seems to be easy. Indeed such world is already divided and we have just to find such division, namely the boundaries. There may be some epistemological problems, but not metaphysical ones.

Although, as already noted in chapter 5, even if one assumes the old dichotomy the problem reappears. Indeed, even a putative example of

[147] I owe the story to F. Bacchini, who told me about it in a private communication.

what should be a *bona fide* boundary would turn out to be instead something else. Consider a river. It may be a boundary, as the Rio Grande between USA and Mexico, or it may be a link between two parts of the same entity, as Tiber in Rome. Consider the example of mountain range. In the case of Alps they divide different Nations. Whereas in the case of Apennine Mountains, the range cross a nation. What in the case of private property? Consider a field. Even if one fences it off, such act is not sufficient in order to establish a right of property, *pace* Rousseau (1992). Therefore, the problem of property would reappear even in presence of *bona fide* boundaries.

There is also a correlated question: are boundaries necessary for establishing the right of property?

The answer seems to be trivial. Indeed, consider two adjacent fields with two different owners. If there is no boundary that divide them, it seems to be impossible distinguish where the power of one of the owner ends and where the power of the other begins. Thus, boundaries are necessary.

How a boundary can be created? Better: what confers the status of boundary to a piece of land? What I claim is that the status of boundary is conferred by a *fiat* act.

It is worth noting that the problem is crucial within the framework of urban planning. In fact, planning in many cases has to assign a land to a certain destination, for instance industrial or residential. Thus, a planner should have the tools to recognize to whom a certain piece of land belongs to.

In a series of publications Smith and Zaibert (2001; 2003), try to explain what make a piece of land the property of someone. They argue that the problem of property within spatial realm is a purely territorial problem since it does not have analogy in other spatial fields. Indeed,

they hold that other spatial things, such as shirts or hats, can be touched or hold and that touching or holding point out the property of such things. Whereas in territorial realm it is impossible to determine the border of the property by the act of touching or holding[148,149].

Thus, the problem of territorial property is a problem of boundaries. Specifically, is a problem that concerns the individuation and the collective identification of such boundaries. Namely: where the boundary of my property is located at?, why is that boundary located where it actually is?, why have I the right of located such boundary where it actually is?

The central question is: how we turn by means of boundaries a free land into a property? In the previous chapter I showed that it is needed a *fiat* act in order to turns something in a boundary. I showed also that there are various kinds of *fiat* act and they are not mutually reducible. Nevertheless, as noted, they may be put together. The case of property is a case of mixed deliberative and collective *fiat* act. Indeed, property presupposes a form of deliberation, namely a person or a group should declare that they own a land. Furthermore, property need a public acknowledgment, namely a collective act that confer to such land the status of property of someone. The machinery beyond such kind of act is regulated by social conventions, laws and habits. My aim here is not to study it. I want just show that (i) also in a world equipped by *bona fide* boundaries such problem would reappear and (ii) the identification of

[148] Other things too can be owned and nevertheless they cannot be touched even if they do not belong to territorial realm. For instance, abstract things such as concepts, ideas, theories. I do not face this problem here.

[149] Furthermore, as noted by Zaibert and Smith 2001 a land has the particular status of being motionless. It means that a land cannot be moved to another region of space, unlike other spatial things. Consider the Italian world for real estate: "immobile". For a reconstruction of the etymology in various languages, see Smith and Zaibert 2001.

boundaries in territorial realm has different rules than in other spatial realm.

6.4 *Fiat* Landscape.

As noted in the introduction of the of the chapter, according to CL in order to define the notion of "landscape" it is needed consider also non-natural factors. In particular, the definition stated in CL describe a landscape as an area as it is perceived by people.

I here first analyze the definition due to CL and then I show why boundaries are relevant in order to give arise a better notion of landscape that gives a full meaning of the one stated in CL.

There are three elements in the definition of landscape by CL:

(i) natural factors;
(ii) human factors;
(iii) perceptions.

The definition by CL is obscure since it does not give us information about the meaning of the expressions. I try here to interpret them, within the framework of *fiat* theory. What I finally claim is that landscape is a putative instance of *fiat* thing.

6.4.1 Natural and Human Factors.

The first kind of factors may be defined as every thing that there is in an area regardless the existence of human beings. The second kind of factors may be defined as every thing that there is in an area due to the existence of human beings. To the first kind seems to belong things such

as flora, fauna, lakes, rivers, and so forth. To the second: roads, buildings, tables. Perhaps also social facts that happen in a landscape, such as parties, meetings, processions, and so on.

Furthermore, the two kinds of factors seems to be discrete: what belongs to the first does not belong to the second and also the converse holds.

Unfortunately, such interpretation is defective for two reasons. The first is the usual one. As it has been stressed in the whole dissertation, since every boundary is of the *fiat* sort, there are no discrete things, at most there is bona fide stuff and thus speaking of natural factors seems to be wrong[150].

Moreover, there is also an empirical consideration against the interpretation of natural factors as things that may exist also without human beings. Consider the flora of an area enclosed by a mountain range. Call it Valley. Assume also that Valley is uninhabited and there are no human artifacts, such as buildings, roads, statues, and so on. The flora of Valley may be considered as a natural factor, since it exists regardless human beings. Nevertheless, if Valley is on planet Earth, it is hit by the wind. And such wind transports pollutions and other results of human activity. The flora of Valley interacts with such human factors. Thus, such flora cannot exist regardless human beings. At least, it cannot exist in the way it turns out to be.

How then can we make sense to the expressions "natural factor" and "human factors"? I think that we can divide humans factors and natural factors by the notion of author:

[150] I here assume that the plural of factors stands to means more than one and according to my definition of things and stuff, only thing may be counted in such a way. Moreover, I also assume that natural means *bona fide*.

Author: x is the author of y iff x deliberate creates y.

Consider a disparate collection of things $z_1,..,z_n$. Such things can be put in a certain way or another in order to constitute a new one. Such disposition may be either casual, for instance made by the wind, or deliberate, namely when someone want to put $z_1,..,z_n$ in the way she wants. Just in this second case we have an author. Clearly $z_1,..,z_n$ may or may not preexist to the author, but their disposition in a certain way is due to the author. Consider for instance an hut made of sticks. Such sticks can preexist the author of the hut but the hut itself is made by a deliberate act of the author and hence it does not preexist her.

We can then say that a natural factor is a factor that lacks an author, whereas an human factor is a factor with an author. We can now say that the flora of Valley is a natural factor since it lacks an author.

6.4.2 Perception and Landscape.

Perceiving a thing is a complex business and philosophy has reflected about that from its early days. It is not my aim here to face that. Such a topic would deserve a whole dissertation. However, I want to shed a light on the reasons of the use of the word perception in the definition of landscape by CL. I then argue that perception is too narrow when we speak about landscape.

The German term "*Landschaft*" was employed from 1484 to denote a kind of painting (Assunto 2006). Likewise, the corresponding terms in Italian and English, "*paesaggio*" and "landscape"[151], has been employed in to denote a kind of painting. In this usage of the term, the role of

[151] For the etymology of the term, see Jackson (1984: 5-13) and Swaffield (1993).

perception was clearly crucial. And it was crucial for two reasons: first, since landscape as an artwork had to be appreciated by the sight. And second and more relevant for our purposes, the boundaries of the landscape as an artwork were the limit of human visual field. Hence, in this conception the area of which the landscape corresponded was the area that was possible to see within visual field. Namely, a landscape was the piece of land that was possible to enclose within a human visual field.

Bonesio (2007) claims that there was a change of paradigm at the beginning of 1900. In fact, from that period the term of landscape has be used for denoting the land itself and not a representation of it. According to Bonesio (2007), landscape has to be interpreted as a land as material representation of the culture of the insiders. Every thing that is put within the considered slice of land has to be analyze as a sign of the identity of the community. For instance, buildings, the ways of cultivate the land, the disposition of transport routes, and so on, have a symbolic meaning and a particular significance for those who dwell that landscape. Hence, a just perceptual approach is not sufficient. We need other interpretative resources, such as iconological studies, anthropology, sociology, religious studies and so on.

That view gives rise two problems: first, since it is not the sight that fix the boundaries of a landscape it has to be found a way to fix them, i.e. where are the boundaries of a landscape. Second, how to interpret the landscape itself as representation of identity, since perception is clearly not enough.

The second question is clearly beyond the aims of the dissertation[152].

Let us then face the first one. It asks where are the boundaries of the landscape.

[152] See Bonesio 2007 for some useful conceptual tools for interpreting landscape.

6.4.3 How to fix the Boundaries of a Landscape.

There are two ways of understand the question: an easy one and a hard one. The easy interpretation of the question demands just to indicate where are the boundary of a given landscape, e.g. the boundary of Riviera del Corallo. It is just needed to find them in conventions or geographical representations of it. Whereas, the hard interpretation demands how to fix such boundary, e.g. why the boundary of Riviera del Corallo are in the regions where they actually are.

The question can be then stated as follow:

What are the necessary and jointly sufficient reasons for fixing in a certain region the boundary of a landscape?

There are at least two answers to that question:

(i) x is the boundary of a landscape y iff y is such-and-such and beyond x the land is not such-and-such anymore.

(ii) x is a boundary of a landscape y iff at x ends the plenitude recognizes by the insiders of y (Kolers 2009).

(iii) x is the boundary of a landscape y iff x is fixed by an accordance between the insiders of y and the insiders of the complement of y.

The first answer assigns to the morphology of the land where to fix the boundary. We can call this "metaphysical answer" (MA).

The second answer assigns to the inhabitants of a landscape the task of fixing boundaries where ends the land they recognize as property. We can call this answer "plenitude answer" (PA).

The third answer assigns to the inhabitants of a landscape and their neighbors the task of fixing the landscape. We can call this "contractual answer" (CA).

I deny that MA and PA may be right answers to the question and I maintain CA is the correct one. However also MA and PA deserve a discussion.

According to MA, the boundary between two landscapes x and y has to be traced where the features of x cease and the features of y begin. The answer entails that there is a region where x ends since its features end to be instantiated. The answer is defective since it can be argued against it using the arguments in chapter 4. In fact, an answer like this suffers of problems such as vagueness and arbitrariness.

According to PA, a landscape ends where ends its plenitude. According to Kolers 2009, plenitude is the capacity of the insiders to give sense and meaning of signs in a landscape. Suppose an area x and a collection of things in that area $y_1,..,y_n$. The group who can give rise of the most meanings for $y_1,..,y_n$ is the owner of that area. It entails that the boundary of x is where such group does not give rise meanings of things located there. The problem with PA is that it is difficult to apply it. Suppose an area with two possible owners. They both create and recognize meanings for the things in that area and nevertheless just one of them is the owner. Which one? The answer seems arbitrary, either way.

The last possibility CA is to rely on decision of a contract between the insiders of two landscapes. It is not denied by the arguments in chapter 4, since CA clearly employ *fiat* boundaries. It also is not arbitrary in the sense in which PA is so. Indeed, CA chose on the basis of collective

agreement between two disputers. How to the disputers may enter into a contract is a complex business, whose elements has to be studied elsewhere.

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