A Sketch of an Ontology of Spaces

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Abstract. In these pages I merely attempt to sketch the basis of an ontology of spaces that may help in formulating the problem of the unification of the real and the virtual within the context of technologies that increasingly blend these aspects.

1 Spaces and Spatialities

We are accustomed in knowledge representation with the notion of abstract space. Abstract spaces recollect properties of theoretical and formal artifacts used to model physical space. Physical space is the space in which we live and interact. It is no surprise that from abstract spaces we can generate more computerized spaces than those intended to model reality. Standalone spaces of this sort (spaces which have in first analysis no connection to reality) are virtual spaces in the most consumed sense. The working hypothesis driving this contribution is that rather than a sharp distinction between real and virtual space there is a spectrum, if not a continuum, of spaces which go from the most real to the most virtual with a number of intermediate hybrids. The notion of space is indeed not as clear cut as a traditional notion of physical space and it may be that the real space which we inhabit is itself an hybrid made of physical parts in a bidirectional connection with virtual ones. This is at least a credible idealization of the thrust of development of computer and information artifacts.

The internet is a prime illustration of an artifact that provides ways for us to interact with the real world and that embeds in itself a spatial dimension as a network, but it is somewhat unsettling to regard the internet and the venues it provides through the variety of existing web applications as an extension of physical space. Nevertheless the internet is spatial in many ways. First it is spatial in a conventional and obvious way for it is at bottom rooted in a network of machines and peripherals that are themselves in physical space. Secondly, as more traditional means of communication like telephone allow to some extent, the internet enables a variety of remote activities and distance interactions significantly enough to genuinely affect the structure of real space in terms of affordances. Thirdly, the internet is spatial in the less conventional and at first view more figurative sense as a space of resources that can be navigated, searched and arranged and in the sense that it turns out to exhibit a number of properly spatial constraints (metrics, topology, accessibility and so on). Finally, the web

has been increasingly developed and presented as an extension to real space to the point that people are sometimes considered denizens of an augmented reality.

Against this background, the question arises of the distinction between the various kinds of spaces with which we are dealing nowadays and how we can prepare to make them better connected. In relation to this my interest is to tease out the elements of a formal framework for dealing with such tentative variety and its putative unification. In other words I'm interested in the (formal) ontology of the spaces (whether real, virtual or of an hybrid sort) with which we will deal ever increasingly in the future.

In the next pages I sketch the preliminary elements of an ontology of spaces in hope that it may serve to lay the framework for asking the questions concerning the variety of more complex kinds of spaces and their interactions. In a few words, my aim is to contribute to the elementary ontological underpinnings of the question of the integration of real and virtual spaces.

2 Elementary Kinds of Spaces

The point of contention in trying to elaborate an ontology of space is whether there is indeed a single genuine category recollecting all spaces, whether of a technical or garden variety. In the introduction I have distinguished three simple kinds, namely abstract, physical or real, and virtual. It is dubious, however, that these make a kind of thing that is homogeneous and that exhibits enough similarity between its instances to warrant being called a kind in a non vacuous sense.

A space is intuitively first and foremost a space of location (or 'locational space' thereafter). That is, it is something such that entities are related to it or to its parts in a specific way which I will refer to as the relation of location. It is natural to draw a distinction between a space and its parts on the one hand and, on the other hand, the entities that may be located in that space. The parts of such a space may be called locations or positions. The entities located at them may be called spatial, but then they are spatial relative to a given space. This notion of space is the one that corresponds best to physical space, for things, including people, are located in physical space in an at least intuitively robust sense.

An abstract space is in contrast only by extension a space of location. It is of course deceptively simple and tempting to simply call 'location relation' (relative to a space) any mapping between a set of entities and the parts of the space in question, whether abstract or not. In that sense any abstract space may be regarded as a 'locational space', but this is misleading. It is in this sense, however, that so-called 'conceptual spaces' [1] can be regarded as spaces.

The characterizing feature of abstract spaces, however, is not that they can be one end of any more or less arbitrary mapping (supporting an arbitrary number of purely formal location relation). It is more useful to think of them not as locational spaces but as abstract objects – such as are mathematical structures – with formal properties that characterize or model the structure of a

locational space. They can do so whether they reflect the arrangement of objects located in a locational space or merely some underlying structure (corresponding respectively to the so-called relational view of space and absolute or substantial view of space [2, Chap. 3]).

Virtual spaces are not physical and so-to-speak bulky in the sense in which the physical space and its parts are. Moreover, the way virtual spaces may be put in correspondence with entities (real ones in particular), establishing locational mappings, resemble the way certain abstract (conceptual) spaces may be locational spaces in an extended way. But virtual spaces do share with physical space the character of having an underlying structure and being amenable to formal modeling. Virtual spaces, moreover, are all informational artifacts or side-effects of such artifactual constructions.

The following list summarizes these distinctions and presents at least three subkinds of virtual spaces which are only roughly distinguished. The distinctions between subkinds of virtual spaces are according to the kind or degree of correspondence with real space in which virtual spaces can be put and are inspired by the fundamentally artifactual character of virtual spaces. It is not entirely clear that these intuitive distinctions form a partition of the category of virtual space nor that the list provided below is exhaustive of the kinds of virtual spaces there are to consider.

- Abstract. For example, a mathematical structure is abstract in the intended sense.
- Physical space, the space of location of things in reality.
- Virtual space, the space of location of things which are not otherwise located in reality.
  - *Simulacre space* which reproduces or models an actual physical space. For example, a virtual version of the British Museum is a simulacre space in the intended sense.
  - *Fictional space* which is a made up space despite any partial similarities with real spaces. For example, the virtual world of a fantasy computer game is a fictional space in the intended sense.
  - *Ersatz space* which supplements real space. For example, a virtual library (e.g. a repository of documents organized or displayed in a spatialized fashion) is an ersatz space in the intended sense.

We can make provisions here for having more or less loose understandings of the kinds of virtual spaces proposed in this list. According to a strict understanding, the list describes separate subkinds of the category of virtual spaces and the typology allows for no overlap nor middle terms. We have to introduce further mixed or hybrid types in order to conciliate the aspects driven at. According to the looser understanding, however, we allow for overlap or at any rate for a gray area between these kinds so that some spaces could fall under one or the other. In other words the boundaries between these kinds are vague.

For the sake of illustration, suppose that the simulacre of the British Museum is used as a basis for the conception of a prospective extension to the real

museum. The extension then is entirely fictional but the new virtual British Museum is arguably a mixture of simulacre and fiction. A strict understanding of the simulacre and fictional kinds would allow to consider only the virtual extension as a fictional space, only the parts of the virtual museum that correspond to the real museum as simulacre, and the whole would fall under neither kinds. A loose understanding of the fictional kind would allow for considering the whole (simulacre and fictional extension) as well as the fictional extension as fictional spaces.There is a similar tugging between ersatz spaces and the other kinds. Suppose the British Museum is replaced by a parking lot and visitors are directed to its simulacre for a virtual visit, perhaps the simulacre plays a role similar as that of an ersatz. But there is also a difference which is that the simulacre does not host the genuine collection of the Bristih Museum, only their virtual counterparts. Suppose now that a user of an alternative reality software decides to place her bank statement in a vault in the corresponding virtual world, then, perhaps, there is a part of the fictional space that embeds an ersatz space.

A loose understanding of the types of spaces described here can be adopted to indicate the diversity of spaces for which these types, when understood in their strong guise, are intended to serve as elements of description. The way to explore the diversity of spaces then is to find as many elementary types as possible so has to attempt the decomposition of others. If such an attempt succeeds, it may be possible to meet the ambition of aligning the variety of spaces along a continuum between the real and the virtual. Although what shape that continuum has, or even whether it is linear or of higher dimensions remains open at such a stage.

3 Relations Between Spaces

In order to fully explore the space of spaces, so to speak, the diversity of kinds of spaces there are and also the natures and degrees of their interconnection, the kinds of relations that may hold between spaces have to be identified. It should be possible to approach the relations and correspondences between different spaces, but also between different kinds of spaces, in a principled manner. The following table indicates basic but generic relations that may hold between two spaces, each space being of one of the general elementary types discussed so far. The first column lists the domain of a relation and the first row its range.

We may call 'formal' the relations that show in more than one row or more than one column for they are relations whose domain or range is not limited to an elementary kind of space. We may call 'homogeneous' a relation that has the same domain and range.

The relation of *comparison* is one that is so labeled for lack of better word but accounts for the fact that spaces of the same kind are similar and thus comparable in a privileged way. It is by our definitions both formal and homogeneous in the extended sense that its arguments have to be of the same kind. Spaces of different kinds are not comparable.

The relation *model of* is here to account for the fact that abstract spaces crystallize at least some aspect of the structure of (locational) physical and

Table 1. Generic Relations Between Spaces

	abstract	real	virtual
abstract	comparison	model of	model of
real		comparison connection interaction	?
virtual		?	comparison connection interaction

virtual spaces. The expression *model of* is used here in a technical sense that is not to be run together with the more casual sense in which a simulacre space was described as a 'reproduction or model' of a real space. A model, in the sense of *model of* is to be understood more along the lines of a purely mathematical or geometrical model than in the sense of a more or less accurate reconstitution.

Connection and *interaction* are relations that are tied to spaces which are locational spaces. Spaces are connected when the entities located in them can navigate between spaces. Spaces interact when entities located in one can interact with entities located in the other. We can make provisions for unidirectional and bidirectional variants of the interaction relation. If we make similar provisions regarding the connection relation also we come closer to dealing with the problem of accessibility between spaces and their denizens.

The foregoing considerations stand as preliminaries to formulating and then answering the question of what comes in place of the question marks in the above table. This is, in particular, the question of the possibility of heterogeneous connection and accessibility between real and virtual spaces. In other words, it is the question, admittedly in its theoretical guise, of the unification of the real and the virtual as might be realized emphatically via internet and its surrounding technologies.

References

1. Gardenfors P. (2000): Conceptual Spaces: On the Geometry of Thought, MIT Press, Cambridge, MA.
2. Sklar L. (1974), Space, Time and Spacetime, University of California Press, Berkeley, CA.