# Reality and Structure of Virtual Space: Some Lessons from Portal

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Introduction[1]

Most computer games locate the player, NPCs (Non Playable Characters), and a number of game assets such as level structure or items in a two- or three-dimensional space. The player sees these objects on his screen or some other output device as being located in space from a specific perspective. In some games he perceives these objects from a first-person perspective, in others from a third-person perspective or from a detached observer perspective. In most games this virtual space plays a similar role in the game as physical space plays in the physical world: it is the background in which all objects are located, it determines the content of the player's spatial experience, and it plays an important role in determining which game assets causally interact with each other, but it is itself invisible and elusive. In some more recent games this space becomes an important gameplay element. In Valve corporation's *Portal* (2007) for example the player has to solve a number of puzzles by creating portals which connect distant areas of space.
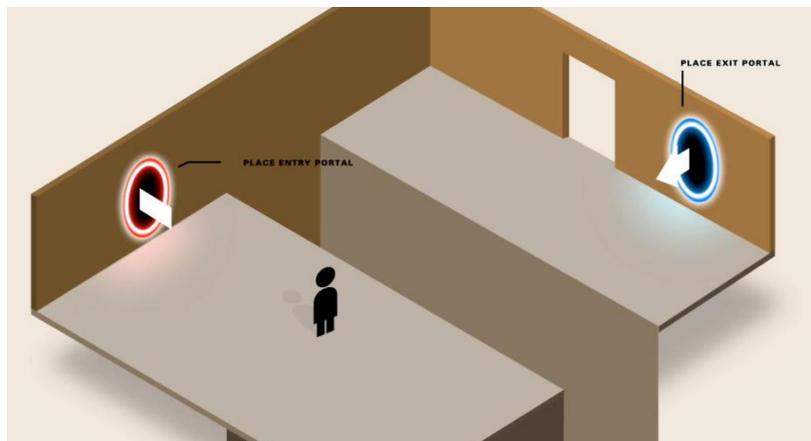
Figure 1: Using the portal gun to get to the level exit.

The goal of the game is to get to the level exit, but the way is blocked by a number of obstacles. The player can circumvent these obstacles by using his portal device (short for "Aperture Science Hand-Held Portal Device"), a device which connects distant areas of space. Only clever use of the portal device allows the player to get to the exit and finish a level.

Such game space in general raises a number of interesting questions, but there are specific problems associated with the game space of Portal and how it is affected by the portal gun. In this paper I will focus on the space of the game Portal. Let us call the three-dimensional space of Portal "VS" for

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"virtual space". And let us call the physical space surrounding us "PS" for "physical space". I will have a look at two distinct questions concerning VS. First, I want to ask whether VS is *real* space in the same way that PS is real space. Second, I want to ask what *structure* VS has. Both questions are only rough and ready formulations and need clarification before we can try to answer them.

The Reality-Question

The question whether VS is real space seems to be ambiguous in two ways and I want to develop a more precise formulation of the question before trying to answer it. The first ambiguity stems from the fact that Portal is what has been called a representational game.[2] Representational games are characterized by two elements, a physical element in the actual world which serves as a *representation* of a fictional element, the thing *represented*. The representational element of Portal is a data stored on some storage device which is apt to produce certain output on computer screens when run on a suitable device and which can be influenced by physical input by a player.[3] This element of a game serves as a representation of a fictional world or scenario, which is the thing represented.[4] In Portal the thing represented is a fictional world somewhat similar to the actual world but in which Aperture Science has developed portal technology and implemented it in the portal device.[5]
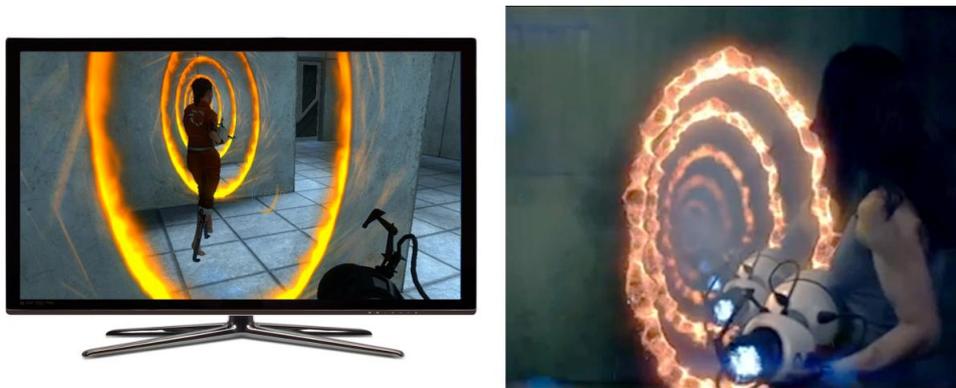

Figure 2: The representation (factual element) and the thing represented (fictional element).

Let us call these two elements of representational games the *factual* and the *fictional* element. The first ambiguity of our question is due to the fact that "VS" could be taken to refer to some part of the factual elements of a game, perhaps those elements of the data of a game which correspond to the 3D-engine and the spatial arrangement of vertices of 3D-models of the game, or it could be taken to refer

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[2] See e.g. (Parlett 1999: 6). Parlett rejects a strict distinction between the two and argues that whether a game is representational depends on the imagination of the individual player. Jesper Juul comes up with a more fine-grained set of distinctions between purely representational and purely abstract games without representational content. In his terminology Portal would presumably count as a Coherent World Game (Juul 2005: loc 1246).

[3] This corresponds to what Juul has called game world (Juul 2005: loc 1511). This element of a game is presumably a multiply realizable physical entity. I take it to include what Nitsche calls the "mediated space [...], which is the space of the image plane and the use of this image including the cinematic form of presentation" and elements of what he calls play space, namely the video game hardware (Nitsche 2008: 15 f.).

[4] I will work with an intuitive understanding of the representation-relation. A possible refinement of this intuitive understanding would be Wittgenstein's account of representation. See (Child 2011: 24 ff.).

[5] The fictional world of Portal is the same as the world of the Half-Life saga, as numerous hints in both games reveal. The ontological status of the fictional element of a game is controversial. According fictional antirealism fictional worlds do not exist and according to Possibilism this can be cashed out as the claim that they are merely possible worlds, i.e. possible worlds which are not actual. For an overview over the debate see (Kroon & Voltolini 2011).

to the space of the fictional element of the game, namely the physical space of the fictional world of Portal/Half-Life.[6] In what follows I am interested in the former interpretation, since I take it to be trivially false that (non-existent) fictional space is real space, for any plausible reading of "real" will entail that if something is real, then it exists.

The second ambiguity turns on the meaning of the term "real space" in the question. Because of this term the question can be understood as a cumbersome way of asking whether VS *exists* or *is real*.[7] Another option is to understand the question as asking whether VS is *genuine* space as opposed to merely something *similar* to space, very much the same way one could ask whether something is *real* leather or artificial leather which merely *looks* a lot like real leather but really isn't leather. How do we distinguish between something which is real x or merely similar to x? On this reading of "real" something is real space/leather/money iff it falls under the extension of the concept space/leather/money. Artificial leather is not real leather because it does not fall under the extension of the concept "leather" and a decoy duck is not a real duck because it does not fall under the extension of the concept "duck". But both have some similarity to the real thing. This is expressed by the qualification of "artificial" and "decoy" in this context as *alienans* adjectives, which are adjectives negating, denying, or casting doubt on the applicability of the noun which they modify.[8] On this latter interpretation of the question we have to find out whether VS falls under the extension of the ordinary concept of "space". Since it is obvious that VS exists/is real in the former sense given our definition of the factual element of Portal, I am interested in the latter interpretation of the question.

We are now in a position to formulate the reality-question in a less ambiguous way:

(1) Is VS, understood as a part of the factual element of Portal, real (i.e. genuine) space?

The answer to (1) depends on the semantics of "space": Under which conditions does something fall under the extension of the concept? In what follows I will adopt a theory about the meaning of spatial terms, among them "space" itself, which has been called spatial functionalism.[9] Spatial functionalism provides the following characterization of the intension of the concept of space:[10]

[Spatial Functionalism] The concept "space" applies to whatever plays the role associated with space in determining which objects interact with each other and in determining the content of our spatial experience.

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[6] This feature of the notion of game-space has also been noted in (Juul 2005: loc 1659). Juul takes "space" in this context to refer to both factual and fictional elements.

[7] I assume that "to exist" and "to be real" are equivalent in meaning. Some philosophers have rejected this assumption, see e.g (Yagisawa 2010: 49 ff.).

[8] See e.g. (Rind & Tillinghast 2008: 80 ff.).

[9] To my best knowledge the term has been coined by David Chalmers and has its first appeareances in (Chalmers 2012) and (Chalmers 2013). Similar notions have been used before by others, Alexander Pruss for example uses the term "location functionalism" in a blog post from October 2011 (http://alexanderpruss.blogspot.co.uk/2011/10/deep-question-for-philosophy-of.html). But the idea of spatial functionalism (at least for some spatial concepts) is much older and goes back at least to David Hume's A Treatise on Human Understanding (section 2 of book I).

[10] Some technicalities: by intension I mean what adherents of two-dimensional semantics call the primary intension or A-intension. For the sake of simplicity I will ignore the distinction of primary and secondary intensions and simply talk of intensions which can be understood as functions from possible worlds to extensions. I also ignore the issues of Twin-Earthability and semantic neutrality which are relevant for the validity of the central argument in this section. But my argument for spatial functionalism is set up in such a way that it also serves as an argument for the non-Twin-Earthability and semantic neutrality of the concept of space (although not other spatial concepts such as "being spherical") and hence for the validity of my argument. For an explanation of the notions of Twin-Earthability and semantic neutrality see (Chalmers 2012: 326, 370).

The core idea of spatial functionalism is that something falls under the extension of a spatial concept iff it plays the appropriate role, be it a causal, counterfactual, or nomic role. So a specific spatial concept such as "being two meters away from one" will pick out any relation that normally brings about the spatial experience of being two meters away.[11] Here is an argument for spatial functionalism: Suppose physicists find out that the fundamental physical nature of our universe is heterogeneous and that distinct fundamental theories of physics are true in the two halves of the universe. Suppose further that in our half of the universe some physical theory turns out to be true in which spacetime is an emergent macroscopic property. Below a certain length it does not make sense to speak of space.[12] In the other half a physical theory is true in which spacetime is a fundamental entity and every object, no matter how small, stands in a certain relation to spacetime. Let us assume that we are someday able to travel from our half to the other. On a macroscopic level we would not notice any difference if we crossed the border between those two halves, it takes elaborate devices to discover that we have crossed the border. Everything *looks* exactly the same after crossing the border. How would we describe the physical environment around us in terms of the concept "space" before and after crossing the border?

It seems to me that the ordinary concept "space" would be applicable in both halves. In both halves there is space and in both halves objects are located in space and have spatial properties which we can see and experience. It is just that "space" picks has a different extension in the two halves. In one of them "space" picks out a fundamental substantive space-structure. In the other it picks out certain non-spatial facts mentioned in the fundamental physical theory which correctly describes this half of the universe.

This is exactly the result that spatial functionalism predicts: in one half substantive space-structure determines which objects interact with each other and causes our spatial experience, in the other certain non-spatial facts determine which objects interact with each other and cause the content of my spatial experience. This seems to be in accordance with how the concept is sometimes used by physicists: if Nathan Seiberg says that according to some theories in physics "space" is an emergent concept and an approximate notion[13] we can understand him to say that space *does* have an extension if one of those theories turns out to be true, but it doesn't pick out some fundamental entity, it picks out a manifold of properties playing the right role. Spatial primitivism on the other hand, the view that the concept "space" picks out some fundamental space-structure if it picks out anything at all, would give us the result that in our half of the universe there simply is no space.[14] This seems wrong and hence spatial primitivism is the wrong view about the semantics of "space".[15]

With spatial functionalism in our tool-box let us turn to (1). Suppose we are playing Portal with an ordinary computer set-up which includes an ordinary output-device, namely a LCD-screen. Would VS fall under the extension of the concept "space", i.e. would it satisfy the conditions specified in [Spatial Functionalism]? Arguably not, for the simple reason that seeing the two-dimensional picture projected on the LCD-screen in itself does not constitute a genuine spatial experience and hence VS does not

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[11] (Chalmers 2012: 295 f.).

[12] For a review of different physical theories which imply that spacetime is not fundamental see (Seiberg 2005).

[13] (Seiberg 2005: 8).

[14] My version of spatial primitivism is slightly different from that of Chalmers' but in most cases they will lead to co-extensional concepts. See (Chalmers 2012: 325 f.).

[15] Spatial functionalism, like other semantic "functionalisms", vindicates the intuition that many concepts in natural languages are *metaphysically tolerant* and would have a referent in a multitude of metaphysically possible worlds containing a variety of distinct metaphysical facts. Van Inwagen formulates this intuition when he writes that certain elements of natural language are "empty of metaphysical commitment" (van Inwagen 1990: 107).

play the proper role in determining the content of spatial experience. VS would play *some* role in deremining my spatial experience by determining the texture of one of the three-dimensional physical objects in my visual field, the LCD-screen, but that it clearly not the role we associate with space.

Figure 3: Oculus Rift generates a three-dimensional visual experience for the player.

Now suppose we play Portal with a virtual reality device such as Oculus Rift[16], the upcoming virtual reality head-mounted display currently being developed by Oculus VR. Oculus Rift uses two relatively small LCD screens (5.6 inch screens in the first prototype) which occupy the players entire visual field to generate a three-dimensional experience of the game-content. The visual experience generated this way is extremely convincing and one reviewer of a prototype characterized it as follows: "With the 3D visuals, the wide field of view, and the motion tracking that shows you whatever your head points at, it feels like you're truly in another world."[17] Would VS fall under the extension of the concept "space" when Portal is played with such a device? Now the player has a genuine three-dimensional spatial experience of the game content. He really sees the game assets as being spatially arranged relative to each other. With good enough 3D-models, textures, and lighting there would be no difference in visual experience between someone who sees the ordinary physical world around him and someone playing a game with Oculus Rift. Does VS play the role we normally associate with space in determining which objects causally interact with each other and in determining the content of our spatial experience? It seems so: VS is the three-dimensional space in which game assets are located, and this space does determine the causal structure between those game assets. The player can usually only interact elements which stand in a certain spatial relation to him. Furthermore VS determines which game assets the player will see, some assets will block the players view of other assets, very much the same way that certain objects in physical space can block our view of other objects in physical space. Hence VS seems to fall under the extension of the ordinary concept "space" and we can answer (1) in the affirmative: VS is real space.

The Structure-Question

If VS is real space we can ask the same questions about its nature or structure that phycisists and philosophers have asked about ordinary physical space. The game-play mechanics of Portal make it interesting to ask what *structure* the space of Portal has and how it is affected by the players use of the portal device. More specific, the game-play of Portal makes it interesting to ask about a specific metrical property of VS and how it is affected by the player's use of portals:

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[16]http://www.oculusvr.com/.
[17]http://www.theverge.com/2013/3/19/4122388/can-oculus-rift-save-virtual-reality. Videos of people using Oculus Rift for the first time give a good impression of how convincing the experience is, see e.g. http://www.geek.com/games/oculus-rift-coaster-demo-is-just-like-the-real-thing-for-developers-wife-1570726/.

(2) Is VS Euclidean space even when there are portals?

How exactly do the portals work? A first hypothesis might be this: the portals do not change the structure of VS at all, they work as teleportation devices and move the player's avatar from one area of space to another area of space. The structure of VS does not change when the player uses portals, it remains a Euclidean space. If so, then the player's avatar would be a scattered object when he is half-way through a portal - he consists of two spatially disconnected body-halves. Another hypotheses is this: the portals connect different areas of space and reduce the distance between them to zero. They generate a shortcut or a Lorentzian wormhole between two areas of space and thereby turn VS into a non-Euclidean space. According to this hypothesis the player's avatar never becomes a scattered object when he walks though a portal.
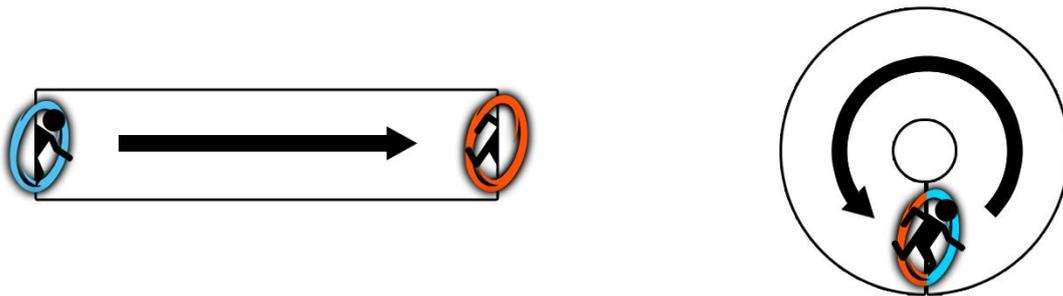
Figure 4: Two hypotheses about portals

Figure 4 illustrates the two competing hypotheses. On the left side the portal is placed within a Euclidean space and the player's avatar is being transported from the right wall to the left wall. In the moment captured by the picture he is half-way through the portal and thus a scattered object. On the right side he is also half-way through the portal. But here the portal works as a wormhole between two areas of space and the player's avatar never turns into a scattered object, he simply walks in a straightest[18] and continuous line in a non-Euclidean space.

Which hypothesis is true? There are two routes we can take to answer this question. One is to proceed the same way we'd proceed in determining whether physical space around us is Euclidean: we take measurement within VS. Is the sum of the angles of a triangle something other than 180 degrees in some areas? Is the ratio of circumference and diameter of a circle something other than π? This would be evidence for a non-Euclidean structure of VS.[19] But even if we would find such evidence there would still be the skeptical worry that the structure of VS is Euclidean but that there are universal forces at play which deform our tools in just such a way that they "mimic" some non-Euclidean space.[20] This is where a second option for determining the structure of VS becomes relevant, one which is not open to us in the case of physical space. We can simply have a direct look at some elements of the referent of "VS", namely the data which constitute the game. The source code of Portal is not public, but according to Jeremy Alessi Portal uses a "traditional teleportation mechanic with a velocity and orientation change"[21]. This verifies the Euclidean hypothesis and we can answer (2) with

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[18] The concept of a straight line is replaced with the concept of a straightest line in non-euclidean geometry.

[19] See e.g. (Reichenbach 1958:7).

[20] Because of this problem Reichenbach argued that the structure of space becomes a purely empirical matter once we adopt the methodological principle that we choose that form of a theory among empirically equivalent forms in which there are no universal forces (Reichenbach 1958:vii, 19 ff.).

[21] (Alessi 2008: 2).

a "yes". But it could have been otherwise. The game Hyperbolic Rogue for example uses genuine non-Euclidean space: its virtual space is a hyperbolic plane.[22]

Conclusion: Some Lessons from Portal

There are some lessons to be drawn from these considerations. The first lesson concerns the philosophical analysis of the notion of virtual space and may be relevant for game studies. Lehdonvirta has pointed out that much influencial scholarship massively-multiplayer online games and virtual environments is based on a dichotomous "real world vs. virtual world" model.[23] One element of this model is the idea that virtual space and real space are mutually exclusiv categories. My arguments in answering (1) give us reasons to reject this idea: studying the semantics of "space" shows us that virtual space and real space have compatible intensions and that in some cases, such as in the case of Portal played with Oculus Rift, they have overlapping extensions.[24]

It is noteworthy that an affirmitive answer to (1) does not commit us to claiming that various game assets such as 3D-models of human beings or tigers are real human beings or real tigers, even when the respective games are played with Oculus Rift. Should it turn out that these models are not real human beings and real tigers (as I think it will), then it would follow that virtual, non-real human beings and tigers can occupy real space.

It is interesting to ask what kind of disagreement there would be between someone who accepts spatial functionalism - and hence that VS is real space - and someone who rejects it. It seems that the disagreement would be one about the extension and intension of a certain concept given agreement about facts concerning the candidate extensions of the concept. Arguably this kind of disagreement is merely a conceptual disagreement and can be resolved by introducing two distinct notions of space, one with a functionalist semantics and the other with a primitivist semantics. They could then agree that VS is space in one sense but not in the other. Their disagreement could also be seen as a disagreement about which of those two concepts of space is more commonly used. This seems to be a purely empirical matter.

The considerations in this paper are an interesting example of a certain phenomenon in metaphysics. The case-study of Portal shows us that semantical facts can ground metaphysical truths. If VS is real space, then, since VS itself is located in physical space, there can be nested spaces. This seems to be a metaphysical truth of some sort. And a semantic fact, namely the truth of spatial functionalism, is grounding this truth. And, as in this case, it is often the study of semantics which helps us determine whether a metaphysical claim is true.

Figures

Figure 1: The image is a modified screenshot of a teaser for Portal released by Valve corporation in 2006. http://www.youtube.com/watch?v=TluRVBhmf8w (last visited: 13.9.2013).

Figure 2: Left image is a screenshot from Portal. Right image is a frame from the short film Portal: No Escape by Dan Trachtenberg.

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[22] http://zenorogue.blogspot.co.uk/2012/03/hyperbolic-geometry-in-hyperbolic-rogue.html.
[23] See (Lehdonvirta 2010). He rejects this model and offers his own alternative.
[24] I am assuming that VS is an instance of a virtual space.

Figure 3: The left image has been obtained from http://www.oculusvr.com/. The right image shows the Oculus Rift dev kit and has been obtained from http://venturebeat.com/2013/04/10/oculus-rift-dev-kit-good-virtual-reality-involves-science-and-easy-assembly/.

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