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► **To cite this version:**

Shahid Rahman. IDEALIZATION AS PRESCRIPTIONS AND THE ROLE OF FICTION IN SCIENCE: TOWARDS A FORMAL SEMANTICS. Olga Pombo. Modelos é Lugares, pp.171 - 171, 2017, 978-972-754-287-1. halshs-01465265

HAL Id: halshs-01465265

<https://shs.hal.science/halshs-01465265v1>

Submitted on 11 Feb 2017

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IDEALIZATION AS PRESCRIPTIONS AND THE ROLE OF FICTION IN SCIENCE: TOWARDS A FORMAL SEMANTICS

Shahid Rahman¹

Preliminary words

One important feature of Poincaré's conventionalism of geometry is linked to the relation between the abstract notion of space geometry and the representations of the free mobility of our bodies. In this sense «the group of rigid motions» identified by Helmholtz and Lie as the foundation of geometries of constant curvature is, according to Poincaré, an idealization of the primitive experience that acquaints us with the properties of space in the first place.² Furthermore, since Poincaré thinks that the only adequate candidates for physical geometry – the geometries of constant curvature – are equivalent from a mathematical point of view (they are homeomorphic), we can choose any one of these. Actually, according to Poincaré, the idealization involved in passing from our own local motions to the group of motions makes use of temporal intuition: our notion of the large-space structure of space assumes that our displacements are infinitely iterables and this assumes temporal intuition.³ Thus, it looks as Poincaré's notion of convention assumes some kind of idealization process. Indeed, the notion of convention involved in these cases seems to assume that in relation to a target system the choice between two idealizations is determined by some kind of equivalence relation, which in our case is displayed

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² See Brenner 2004, DiSalle 2002

³ Cf. DiSalle 2002, 171.

by homeomorphisms. However, usually, idealizations are thought to be the result of an abstraction from empirical data and the choice of one or the other geometry as idealizations of our own mobility would then confirm that some kind of empirical invariant is somehow passed over by the different translations. However, this clearly contradicts Poincaré's definitive rejection of empiricism. Indeed, the first main aim of this paper is to study the step of idealization in a general way, a way compatible with the general aims of Poincaré's view on conventionalism. More precisely we will discuss the recent theories of models in science as games of make believe, where models are conceived not as *descriptions of facts* but as *prescriptions* to imagine or to build a determinate situation in analogous way to the games of pretence involved in literary fiction. According to this view, idealizations are not descriptions but prescriptions.

Now, the applications of make believe to models of science is usually linked with an irrealist approach: the objects prescribed by idealizations do not exist, or more bluntly, the prescriptions do not denote any object at all. This presents some difficulties when we would like to compare the models with nature: how should we compare if one of the terms of the relation is lacking? The second main aim of the paper is to defend that the artifactual theory of fictions provides a plausible ontology compatible with the theory of models as prescriptions. The version of the artifactual theory, developed in collaboration with **Matthieu Fontaine**, makes use of Amie Thomasson's reconstruction of ontological dependence of Roman Ingarden.⁴

The very point of the paper is not to describe the «process» of idealization but rather to explore the semantics of a notion of idealization conceived as a prescription to imagine.

Models are not descriptions

Since the work of Patrick Suppes and Bas van Fraassen, sciences are viewed mainly as involving models and modelization. The developments of J. Sneed, W. Stegmüller and later on of W. Balzer and U. Moulines understood models in the sense of mathematical models. More recently, the approach has been extended in order to include also the case of modelization where models are understood as scale models such as wind tunnels or even maquettes analogous to those used by architects – see e.g. the work of Roman Frigg. Now, models, in this very general sense prescribe to assume quite extraordinary conditions: models prescribe to assume in Biology for example, infinite populations or that all fishes are either preys or predators interacting according to a simple law, in economy that there are perfectly rational agents and dealings are done in no time and in Physics, that objects are without mass, perfectly round and immune to air

⁴ Cf. **Rahman / Fontaine (2013, 2014)**.

resistance. However, we know that this is not the case. If models were thought to be descriptions of facts then they lie shamelessly. In *How the Laws of Physics Lie*, Nancy Cartwright claims that a model is a work of fiction. So far so good, but two questions have to be addressed now,

- If models are not descriptions of facts, what are they?
- Why do they work?

I will present a brief overview of the recent answers to these questions based on the theory of make believe such as in the recent work of Roman Friggs (London School of Economics), Arnon Levy (Harvard), Adam Toon (Cambridge), and Peter Godfrey-Smith (Harvard). These researches seem to have been triggered by a suggestion of Annouk Barberousse at a conference on the role of images in science. The answer to the first question is, according to this approach, a prescription to build up a model under the assumptions involved in the prescription. The answer to the second question is related to the issue of the idealization triggered by the prescriptions.

Both answers assume the theory of make-believe of Kendall Walton that actually is a theory on fictions. Let us start then with presenting briefly those points of the theory of Walton that have been applied in the concept of models and idealization.

I.1 Creation as *make believe* and the *voluntary suspension of disbelief*

The very point of Walton's theory is a dynamic approach to the notion of fiction resulting from the complicity of author (or storyteller) and reader (audience). An author is not a liar; the liar is trying to get the audience to believe the things he says, whereas the author (storyteller) of a fiction is trying to get the reader (audience) to *make believe* the things he says. Thus, when does the author succeed in making believe that, according to a given story, *p* is the case? Well, when the reader, in the context of that story, is willing to suspend his incredulity in relation to *p*. The stress on the «voluntary suspension of disbelief», picked up from Samuel Stanley Coleridge (1772-1834), displays the core of the theory. Accordingly, the creation of a literary work results when the game of make believe involved is willing to be played by the intended audience. Now, what really differentiates Walton's approach to those of other pragmatists such as Currie and Searle is what triggers the game of make believe or pretence. Indeed, for Walton, the pretence proper of fiction is prompted by the presence of a particular world real object (fact), in which case this object is referred to as a *prop*. A real world object becomes a prop due to the imposition of a rule or *principle of generation*, prescribing what is to be imagined as a function of the presence of the object. If someone imagines something because he is encouraged

to do so by the presence of a prop, he is engaged in a game of make-believe. Fictions – including linguistic fictions, representational paintings and sculptures – serve as props in games of make-believe. A text constitutes a fiction when, roughly, there is a rule in force that we are to make believe that there are objects and/or facts such that the words of that text refer to and describe those objects and/or facts (thus, we make believe that ‘Anna Karenina’ is a genuine proper name that directly refers to a Russian woman of whom the story is telling us, and so on.). The fictionality of a proposition consists in there being a prescription from the prop-facts to the pretended proposition, in a given cultural context, that participants imagine it to be true. Children may play that bicycles are horses and in the context of such a game all that is needed, for the prescription to make believe that horses are in a corral to be in force, is the fact that the bicycles are in the garage. According to Walton’s view, we only make believe that through Tolstoy’s sentences about Anna Karenina we get genuine reference, predication and truth. Here the sentences of the text will play the role of the prop.

As already mentioned, props generate fictional truths in such games (thus in a game in which the rule is that stumps are to be imagined to be bears, a stump by its presence generates the fictional truth that a bear is present). Some rules of generation are ad hoc, for instance when a group of children spontaneously imposes the rule that stumps are bears and play the game ‘catch the bear’. Other rules are publicly agreed on and hence (at least relatively) relatively stable. Games based on public rules are ‘authorized’, games involving ad hoc rules are ‘unauthorized’. By definition, a prop triggers a literary fiction if it is a prop in an authorized game. Borges’ *Tlön Uqbar* is a literary fiction because everybody who understands Spanish is invited to imagine its content, and this has been so since the work came into existence.

Now, what is this fictional truth? Well the fictional truth amounts to the introduction to fictional operator to be read as *according to the story...*

Unfortunately, the truth-conditions or better the logic of the pretended truth of propositions in the scope of a fictional operator have not been yet described, we only know that they are quasi assertions expressing quasi-truths. Truth-conditions might be accomplished by the means of supervaluations and what I would call Bencivenga *superinterpretations* but I will leave this for the discussion, since I prefer another solution based on the artifactual theory of fiction.

I.2 Models and Imagination

According to Frigg and others, Walton’s version of the pretence theory has the resources to answer to the issues on what is a model in science. In the same way as texts are taken to be props in games of make believe that prescribe to

imagine a given situation, description of scientific models should be understood as props in games of make believe typical of science. According to this approach, saying that a hypothetical entity possesses certain properties involves nothing over and above saying that within a certain game of make-believe we are entitled to imagine the entity as having these properties. For this reason, according to Frigg, there is nothing mysterious about ascribing concrete properties to nonexistent entities.

According to this approach, the pretended truth amounts to the fact that the prescriptions involved in the model description invited the audience to make a trip into a world where the voluntary suspension of incredulity will take place. The actual world is excluded because in the actual world the propositional content of the model would be quite often false. Furthermore, the point is that this corresponds to the standard semantics of believe: If X believes ϕ , ϕ has not to be true in the actual world. Worlds are here conceived as variations of the actual world and sentences within a fictional operator will be considered to be true if they express true propositions in all such worlds that (i) are compatible with the model description (ii) that are able to complete the model description.

Notice that the first condition produces the selection of a subset of worlds that are closed in relation to logical inferences. That is, those explicit and implicit truths generated by the prop and the background knowledge

The second condition stresses the fact that the truth conditions are set over a plurality of worlds. This should tackle the problem of the incompleteness of fictional texts and models. Indeed, scientific models are incomplete as fictions are. Not all properties can be said to apply or not: if we have an oscillator-model in relation to a target systems of a bob bouncing on the end of a spring, we will be invited to imagine a situation where we use some version of Newton's Second Law with Hooke's Law in mind, but the model description will probably not include any assertion about the colour of the spring. Thus, if we take the model as such, the story as whole, it is incomplete: it is not neither asserted nor denied that the spring is, say, dark blue. However, in some of the worlds it will be true and in some false.

Actually, I modified a bit Frigg's own description where it looks sometimes that the semantics of the fictional operator assumes only one world but this is certainly a mistake. One of the main arguments of Frigg to distinguish the fictional work from the possible worlds is that the first ones are incomplete but the second ones not. Now, in the version I used above, the semantics of the fictional operator is developed with the help of a whole set of worlds. I will come back to this later on.

However, let me at this point quote Frigg:

This analysis of truth in fiction carries over to model systems one to one simply by replacing p [where p is a placeholder for an intrafictional proposition] by a claim about the model, [the fictional work] w by the description of the model system, and w-principles of generation by the laws and principles assumed be at work in the model. For instance, 'the

solar system is stable' is true in the Newtonian model of the solar system systems iff the description of the system together with the laws and principles assumed to hold in the system (the laws of classical mechanics, the law of gravity, and some general assumptions about physical objects) imply that this is the case.

Objections

So far so good but let us start with the objections. If models are fictions and invitations to suspend our incredulity, why do they work? How is that models somehow represent sometimes a very determinate target system? Take the case of Poincaré: how is that the models of space geometry represent the free mobility of our bodies?

Frigg considers that the hypothetical entities prescribed model descriptions are not existent and more precisely they are rather semiotic productions than entities that can be denoted. If this is the case, how should we compare them with the real objects of the target system? According to Frigg's view, what are to be compared are the properties that the objects at stake have, not the objects in itself.

Unfortunately, this strategy will not work from the very irrealist semantics assumed: where should we set the comparison? In the actual world? However, if we assume that hypothetical entities are not entities after all then all the assertions about the hypothetical entities will be false? Should we set the comparison in a new fictional world? Actually, this solution is the one Walton suggests, but for the purposes of models in science, it does not look that it could be useful. Should we pretend in a second game that what exists in the actual world does coexist in the fictional world where the hypothetical entities exist? What we need is rather to consider hypothetical entities to be somehow in our real actual world, not in a distant one. Should we then come back to a kind of Meinongianism with nonexistent objects inhabiting our world?

Now, let us leave for an instant these objections and assume that somehow we manage to compare the hypothetical objects of the model and the real objects of the target system. Why does the model work anyway? The answer in short is that the model system should be considered as an idealization of the target system. The distortions due to an idealization should preserve some features that are considered relevant to the understanding of the phenomenon at stake. In physics normally we think in «causal understanding» but this is not exclusively so. Furthermore, if we come back to Poincaré, who stresses quite often the issue of understanding idealization assumes, in our reconstruction, some kind of prescription to build up a fictional stage that will then be measured by its understanding of the phenomenon at stake: the free mobility of our own bodies.

Now this cannot be put into work until we do not have an appropriate way to tackle the hypothetical objects of the models. At this point, I propose to introduce a reconstruction of the artifactual theory of fiction.

II. The Artifactual Theory

II.1 Fictions and Intentionality

In the formal approaches to the semantics of non-existents, predicate of existence is combined in various and different ways with quantifiers. However, the phenomenological tradition has another device to deal with non-existence, namely intentionality and more precisely the notion of ontological dependence of Brentano and Husserl. Influenced by the work of Roman Ingarden (1893-1970), a Husserl's student, Amie Thomasson develops the concept of ontological dependence in order to explain how we can refer to non-existent objects for example in the context of literary interpretation. Let us first present the general framework of intentionality as understood by Thomasson and compare it with the positions mentioned above. I take the choice to follow the interpretation of Thomasson of intentionality in general and of Ingarden in particular, since at the very end the aim is to offer a semantic for her artifactual theory of fiction – by the way she has an excellent entry on Ingarden in the *Stanford Encyclopaedia of Philosophy*.

The task of a theory of intentionality, as duly stated by Thomasson, is to offer an analysis of the directedness of our thoughts and experiences towards those objects in the world that they are about. John Searle, Barry Smith and Ronald McIntyre reconstructed Husserl's *content theory of intentionality*. This reconstruction, developed within the spirit of analytic philosophy, is at the base of Thomasson's approach to intentionality.

The content theory of intentionality

According to the *content theory*, ordinary intentional relations to our veridical perceptions are constituted by three basic parts:

- The conscious act, the object and the content. The conscious act is the particular perceiving, thinking, wishing... that occurs at a particular place and time.
- The object of the intentional relation is the thing the conscious act is about, normally, just a physical individual or state of affairs.
- The content of an act opens the access, in a similar way to Frege's senses, to the object of the intentional act. The content is dependent upon the subject's conception or angle of perception of the object and thus each content specifies a particular way to conceive the object at stake.

In the content theory framework salient distinctive features of intentionality are:

- Existence independence: the purported fact that intentional acts need not to be directed at any existent object – notice how close it is to Frege’s conception of senses without denotations.
- Conception dependence: the fact that one and the same object may be acceded by two different contents, and thus by two different intentional acts – recall once more how according to Frege, two senses might pick up the same denotation.
- Context sensitivity: the dual nature of the conception dependence, that is, the fact that two internally indistinguishable intentional acts (acts with the same content) might pick up different objects in different contexts.

Objections:

The main objections against the content approach target the cooperation of the three principles mentioned above.

Let us assume that X has thoughts about, say, *Mahatma*, and the *creator of the passive resistance movement*. Furthermore, let us assume that X has also thoughts about *Orestes’ sister* and *Iphigenia’s sister*. In the first case, because of Conception independence, we know that both different intentional acts pick up the same object, namely the individual *Mohandas Karamchand Gandhi*, since an object is there. Now, how can we be sure that in the second pair of acts X is thinking about *Electra* (we take it that she is a fiction) and not about *Quetzalcoatl*? There is certainly content, but because of Existence independence, there is no object.

The logical consequence of this approach is the Fregean inspired Negative Free Logic point of view: every proposition about fictions – with the exception of negative existential claims – is false. Frege proposed even that all fictions denote the same object: the empty class.

Now, content theorists, proposed some ways out of the dilemma. The unification of the acts involving fiction could be explained by postulating that the experience of these acts is as *if they were of the same object*. There is a phenomenological individuation of the object *for consciousness* though there is no external object. The assumption of an *if-object* for consciousness, seems to be compatible with the approach of make believe Walton and the superinterpretations theory of Bencivenga. Smith and McIntyre define the phenomenological individuation by means of a background of beliefs about

- Principles of individuation for the kind of the individual given. A human being, an animal and so forth. In our case, *Electra*, a woman.
- Identity-relevant properties for that individual: in our case, the property of

inducing Orestes to kill Aegisthos.

These might be used to distinguish those acts about *Electra* from those about *Quetzalcoatl*: the content about humans is certainly of a different kind of that about feathered snake-Gods. However, as pointed out by Thomasson, in many cases the individuation procedure described above will not work. Fictions do often violate the categorical principle of individuation of our background knowledge: humans are not insects. How can we explain that the contents of our thoughts about *Samsa* are also about the insect into which *Samsa* has been transformed? Worse, let us assume that we have the same content and that the phenomenological individuation conditions are satisfied, how should we distinguish instances of context sensitivity? That is, how should we distinguish Cervantes' *Don Quijote* from, the *Don Quijote* written by someone else, like in the short story *Menard, author of the Quijote* by Jorge Luis Borges?

The intentional object theory of intentionality

Thomasson's approach to intentionality has its roots in the work of Kazimierz Twardowski (1866-1938) according to whom:

We must discern, not just a twofold, but a threefold aspect of every presentation: The act, the content and the object.

This view of Twardowski is also followed by modal Meinongians such as Zalta and gives the ground for their endorsement to the thesis that every singular term has a denotation. The following point is less akin to the Meinongians and is crucial for Thomasson's approach:

The intentional object theory of intentionality explains the phenomenon that the objects of our intentional acts «need not exist» in part by rewriting this claim. The objects of our intentional acts need not be physical, spatiotemporal, or ideal entities, and they need not exist independently of intentional acts. This is because one term (the object term) may depend in a variety of ways on the other term (the intentional act) and may even (in the case of creative acts of fictionalizing or hallucinating) be brought into existence by that very intentional act.

Since this approach assumes an object, the objections to the content theory cannot be raised against this conception of intentionality.

II.2 Fictions and models as creations

The key of Thomasson's approach to fictions lays in acknowledging fictions a

full ontological status. According to her view, fictional objects are inhabitants of domains of worlds just like non-fictional ones. On one hand, they are creations or more precisely, artifacts like chairs, buildings and on the other hand, they abstract creations such as marriages, universities and theories. Fictional objects are bounded to the everyday world by dependencies on books, readers and authors. In her book, *Fiction and Metaphysics* Thomasson displays several types of ontological dependence, we will take up only two main kinds, namely *historical* and *constant dependence*, and both have their roots in Ingarden. Ingarden distinguishes, among other, between the following sorts of dependence:

- *Contingency*: the dependence of a separate entity on another in order to *remain in existence*. Corresponds to Thomasson's constant ontological dependence.
- *Derivation*: the dependence of an entity on another in order to *come into existence*. Corresponds to Thomasson's historical ontological dependence.

According to Ingarden, a fictional character is created by an author who constructs sentences about it – fictions have thus a derivative dependence on their creators, but it is maintained in its existence thereafter not by the imagination of individuals, but by the words and sentences. Thomasson, as already mentioned, develops these notions of Ingarden and combines it with the idea of *rigid* and *generic* dependence:

We can begin by distinguishing between constant dependence, a relation such that one entity requires that the other entity exists at every time at which it exists, from historical dependence, or dependence for coming into existence, a relation such that one entity requires that the entity exist at some time prior to or coincident with every time at which exists. (Thomasson, 1999, p.31)

The point is that the fictional character Holmes is ontologically historically dependent on Conan Doyle and that Holmes as an artifact or creation can survive even after Doyle is dead. Moreover, the ontological dependence is in this example a *rigid* one: Holmes depends historically on a fixed object, namely Doyle. Now, after Doyle's death Holmes survives as an artifact because it is ontologically sustained by copies of the texts of Doyle. In fact, while the historical dependence relates to the creation act, the role of the constant ontological dependence is to assure that the artifact Holmes, once created by Doyle, is still here despite that his creator is not. In other words, the constant ontological dependence assures that artifacts are denizens of our world. Furthermore, if also the object(s) on which Holmes constantly depends disappear, also Holmes will disappear or at least be inaccessible. Important for these kinds of examples is to allow the constant ontological dependence relation to be *generic*, that is, Holmes is not constantly dependent on one particular copy

of the texts, but at each time he is constantly dependent on one of the copies (or memories). The historical dependence relation is transitive and asymmetric. Reflexive cases of the relation of constant dependence can be used to define independent objects (see definition 6 below). Interesting is that ontological dependence is to be thought as being bi-dimensional, that is, in a frame of worlds and moments of time with their respective relations. Indeed, Thomasson writes

Assuming that an author's creative acts and literary works about the character are also jointly sufficient for the fictional character, the character is present in all and only those worlds containing all of its requisite supporting entities. If any of these conditions is lacking, then the world does not contain the character. If Doyle does not exist in some world, then Holmes is similarly absent. If there is a world in which Doyle's work were never translated at all and all of the speakers of English were killed off,..., then Sherlock Holmes also ceases to exist in that world,... (Thomasson, 1999, p.39).

If historical dependence allows the creations to survive the creator, then the situation described in the quote above is only possible if we are talking in a bi-dimensional framework of world and time. Doyle must be present in the same world where Holmes is present, but not necessarily at the same time.

II.3 Dependence ⁵

Historical dependence

The Eigenart of fictional objects (and any other artifacts for that matter) becomes, according to this approach, clear in connection with a multitude of worlds. They are ontologically dependent objects. Any such object requires for its existence the maker of this object (while the converse requirement does not prevail). For instance, Sherlock Holmes exists only in those worlds in which Conan Doyle does, while there are possible worlds with Conan Doyle but without Sherlock Holmes.

X requires Y if in every world in which X exists, also Y exists. X depends on Y if X requires Y but Y does not require X. Note that under this definition, both Holmes and Watson depend on Conan Doyle. What is more, supposing that according to the oeuvre of Conan Doyle, Holmes and Watson are without exception co-existent, we must conclude that Holmes requires Watson and that Watson requires Holmes. Just because of their symmetrically requiring each other, we avoid the undesirable conclusion that one of the two characters depended on the other. Observe also that by this definition, any object requires itself, but no object depends on itself. Now, actually we should add a temporal aspect. It is surely the case that in no world may Holmes's occurrence precede

⁵ Cf. Rahman / Fontaine (2012, 2014).

Conan Doyle's occurrence, yet it is surely the case that in no world may Holmes's occurrence precede Conan Doyle's occurrence.

Notice that the approach is ontological rather than epistemological. We might not know who the creator of the table I am writing on is, but I acknowledge that someone must have done it.

The first two definitions below should capture what Thomasson calls «historical rigid designation» in a bi-dimensional framework. In other words frames, constituted by a set W of worlds (situations), a set T of moments of Time, and two relations, namely, the standard accessibility relation R , defined on W and the relation «earlier than» $<$ defined on T . The valuation function will be defined on pairs $\langle w, t \rangle$.

Definition 1. (*Historically requires*) Object δ_i **historically requires** object δ_j ($i \neq j$) at time t , if for each world w and all times $t' \geq t$ for which $\delta_i \in D^{t'} w$, we have that there is at least one time $t'' \leq t'$ such that $\delta_j \in D^{t''} w$.

Definition 2. (*Historically depends*) δ_i **historically depends** on object δ_j ($i \neq j$) at time t , if δ_i historically requires δ_j at t , but δ_j does not historically require δ_i at t . When this is the case and the interpretation of k_i, k_j at w, t is δ_i, δ_j , we say that \mathfrak{R}_{k_i, k_j} holds at w, t , for short: $w, t \models \mathfrak{R}_{k_i, k_j}$

Constant dependence

As mentioned above, this kind of relation is crucial for the «existence» and «death» of the fictional characters as depending on the copies of the correspondent works. However, certainly some copy is responsible for this ontological dependence and not all of them. Moreover, the generic feature explains the abstract character of fictions and more generally of the literary work. Let us once more quote Thomasson:

A literary work is only generically dependent on some copy (or memory) of it. So although it may appear in various token copies, it cannot be identified with any of them because it may survive the destruction of any copy, provided there are more. Nor can it be classified as a scattered object where all of its copies are, because the work itself does not undergo any change in size, weight, or location if some of its copies are destroyed or moved.

But copies of the text are the closest concrete entities on which fictional characters constantly depend. ... Because they are not constantly dependent on any particular spatiotemporal entity, there is no reason to associate them with the spatiotemporal location of any of their supporting entities. (Thomasson, 1999, pp.36-37)

Definition 3. (*Constantly requires*) Object X **constantly requires** object Y at time t , if for all worlds w for which $X \in D^t w$, we have that $Y \in D^t w$.

Definition 4. (*Constantly depends*) X **constantly depends** on object Y at time t , if X constantly requires Y at t , but Y does not constantly require X at t .

Definition 5. (*Constantly generically depends*) If t is a fixed time, let Γt be a set of objects such that each of these objects exists at time t in some world. We may call Γt a *type* or *genus*. Object X **constantly generically depends** on genus Γt at time t , if for all worlds w for which $X \in D^t w$, we have that there is $Y \in \Gamma t$ such that $Y \in D^t w$.

Definition 6. (*Independence*) X is ontologically **independent** if it constantly requires nothing else as itself.

II.4 The creation of fictional works

The fictional operator

In the preceding paragraphs, we defined the different kinds of ontological dependencies in relation to objects, but in Thomasson's theory, the whole work should be considered as an artifact. The point is to provide the semantic counterpart to the introduction of an operator of fiction that should allow the evaluation of sentences such as «According to the story, Holmes is a detective». The truth-conditions for the fictional operator deployed by Thomasson are still lacking. The present reflections should provide the basis for such semantics. However, before we go to the formal semantics let us introduce Thomasson's decomposition of a literary work. According to our author, a literary work can be divided in three components:

- *Text*: the sequence of symbols in a language or languages.
- *Composition*: the text as created by the author. That has been explicitly written. We call *content all* what is logically compatible with the composition (see more precise definition below). This poses logical restrictions on the author and is related to the Aristotelian discussion on *likelihood* mentioned above.
- *Literary work*: the interpretation or the reader perspective with their background.

For each of these we can speak of the abstract type or token. The type texts are those that are responsible for the constant ontological dependence. Compositions tokens are separated by the authors upon whom they depend: different authors, different compositions. Two interpretations tokens of the same composition might deeply differ: think in mythology. From the point of view of

Thomasson, the make-believe approach reduces all the work to literary work or interpretation.

Our proposal for the semantics of the fictional operator is to interpret both the «content» and the interpretation of the fictional work as displayed by a plurality of worlds. For reasons of simplicity of exposition we will leave the temporal aspect aside and speak of worlds instead of pairs $\langle w, t \rangle$.

The content: *We take the construction according to the fiction, ϕ holds ($: \mathcal{F}\phi$) to behave formally as a modality. What this means is that we take the story to specify (relative to the actual world — or if that for some reason does not suffice, relative to a number of other worlds as well) the totality of all the worlds that are compatible with all that the fiction says. That ϕ holds according to the fiction then means that ϕ holds in all the worlds compatible with the fiction. That is, the content consists in the explicit sentences of the work plus its logical implication.*

The interpretation of the reader's perspective: We may also be interested in statements that are true only in *some* world compatible with the fiction. Here we introduce the reader's perspective. For example, presumably the oscillator model mentioned above leaves it perfectly open whether the oscillation object is dark blue or not. The latter is compatible with the story while surely not necessitated by it. While *according to the fiction, ϕ holds ($: \mathcal{F}\phi$)* expresses a universal modality, *ϕ is compatible with the fiction. ($: \langle \mathcal{F}\phi \rangle$)* is an existential statement.' We may even read $\langle \mathcal{F}\phi \rangle$ as *the fiction admits an interpretation according to which ϕ*

- It is the interpretation the means by which the model could be compared with the target system.

Each of the worlds displaying the content and the interpretation will be conceived with a domain $D1$ partitioned in two domains, namely $D2$ and its complement: $D1 \setminus D2$. What each of the domains is requires some discussion but in general, we can say that in $D2$ one finds all what the fiction says there is (at that world). In literature studies, there are two opposed positions:

Impermeability: Many scholars of theory of literature, perhaps even most of them, think that the «real» elements occurring in fictional works are not in fact real but rather creations based on same characters of the real ones: the Napoleon of *War and Peace* is not the real Napoleon. Fictions, to use the language applied to Genette, are «impermeable in relation to element of reality». Let us call this position the *strong impermeable point of view*.

In our setting, the case of strong impermeability by considering that the

relation of ontological dependence divides $D1$ in two disjunct subsets: the ontologically dependent and the ontologically independent objects. The problem with impermeability is that satiric is not possible: the object of satiric is not the real one.

A way out is a less strong version of impermeability that we might call *weak impermeability*. According to this theory, Napoleon is, from the internal point of view, a denizen of the domain the fiction talks about but the reader might relate it to the real Napoleon and even in some cases identify the fictional with the real one. Such an approach would really need a totally different formulation of the semantics of quantifiers, namely Hintikka's world-lines conception. We cannot work it out here but it will be mentioned very briefly at the end.

Permeability: Others, from what we might call *the permeable point of view*, assume that real objects could appear in fiction, but fiction is what is added to that real object: intuitively speaking. From this point of view, fiction adds «invented» statements about reals. That is, those statements will be false outside the scope of the fictional operator. In this approach, $D2$ and its complement do not strictly represent the division between dependent and independent objects. Napoleon, the (at the actual world) «real» independent individual, might be an element of the domain of (quantification) $D2$.

The actual world: The actual world is the world where the evaluation is performed outside the fictional operator. It contains all objects, including the corresponding fictional characters, the objects upon they ontologically depend and even other fictions and objects. In other words, at the actual world the domain is $D2=D1$. True statements in relation to a given w about objects that are elements of D^{w2} will be false in the actual world: *Holmes is a detective* is false in the actual world. Indeed, *Holmes is a detective* according to the story, not in the actual world.

Let us here sketch the semantics of the fictional operator from the permeability point of view. The adaptation to the case of strong impermeability is straightforward: we have to assume that no interpretation of a constant at a given (non-actual) world might yield an object that is element D^{w2} and is ontologically independent in the actual world. The case of weak impermeability is more delicate (see discussion at the end of the chapter).

The fictional operator from the permeability point of view

Worlds are otherwise defined standardly, but, as mentioned above, it is now intrinsic to the world that its domain is given in two pieces. Moreover, it will have an internal structure (determined by the story). Let us for simplicity consider the case where we only have one unary predicate P , one binary

predicate Q and two constants k_1 and k_2 . In the standard case, a world w would consist of a domain together with the adequate interpretations defined as usual for the semantics of varying domains, where k^w and P^w stand for the values of the interpretation functions at the given world w .

- In our case worlds will be structures of the form $w = (D_1, D_2, P^w, Q^w, k_1^w, k_2^w)$, where $D_2 \subseteq D_1$.
- Constants are also in this case interpreted on the whole set D_1 : $k_1^w \in D_1$, and $k_2^w \in D_1$.
- Predicates are interpreted on D_2 : $P^w \subseteq D_2$. $Q^w \subseteq D_2 \cdot D_2$

Our worlds have thus a domain D_1 equipped with a distinguished subset D_2 . The point is that the distinguished subset D_2 will determine the ranges of the quantifiers in worlds compatible with a given fiction. To assert that something exists at the non-actual world v amounts to assert that this something is an element of D_2 . The reason why the interpretation of constants is however determined on D_1 is the fact that we want to leave open notably the possibility of letting constants refer to objects in $D_1 \setminus D_2$, though these objects might not «exist» in the world at stake (i.e. the interpretation of a constant might be outside the scope of the domain of quantification of this world). The reason why the interpretation of predicates must lay on D_2 is that we would like to preclude that, at non actual worlds, entities, assumed to be existent at that world might interact with some not assumed to exist in that world: if an object without mass exists in a given world but the sun (with its characteristic «real» properties) does not, we do not want to have that the object without mass of the model interact causally with the real sun.

One feature of our semantics is that we assumed that all constants of our language refer; indeed, they refer at least in D_1 . This can be changed by means of the introduction of partial interpretation functions, but for the sake of simplification, we will not do this now.

Notice that, if an object called k , say the «real sun» is not part of D_2 – at a world v that realizes the story –, he does not exist there. Under such an assumption $\neg \exists x(k=x)$ will be the case at v . The point is that the interpretation k might lie beyond the values assigned to the variables of the quantifiers at the world at stake, say v : the value assigned to k might be not an element of the domain of D_2 . Notice too that if we really provide our language with equality it will be natural to assume that in every world identity of objects within or outside D_2 holds. This means, that in the non-actual worlds, equality could apply to objects that are not necessarily elements of D_2 and thus, in those worlds a positive free logic will hold. Indeed, if k is not element of D_2 from $k=k$ we cannot infer $\exists x(x=k)$. Dually, if neither k nor m are elements of D_2 we cannot infer $\neg(k=m)$ from $\forall x \neg(x=k)$.

Models are structures consisting of a set W of worlds of the kind just explicated and a relation R of accessibility among those worlds determined by the fiction being considered. Intuitively, the creator of the fiction (and whatever else we count as objects on which the fiction depends) is found in the «first domain» of each world v accessible from w (where w is thought of as the actual world, i.e., the world in which the fiction was created). We do not preclude, as already mentioned, the possibility that in the «second domain» there might also be some non-fictional objects, in some cases even the creator of the fiction. However, as far as the fictional objects are concerned, the object on which they depend is (or, the objects on which they depend are) always thought to be found at least in the «first domain.» In the case of fictions written by Conan Doyle, Conan Doyle himself is considered as being in the «first domain» of each world accessible from the actual world; Holmes and Watson are in the «second domain» of each world. Once more, if we assume that the sun exists in some world of the model (is an element of the second domain in some world), then it might be true at that world that the sun interacts causally with some object of the model.

Formulae ϕ are evaluated in models $M = (W, R)$ at worlds $w = (D1, D2, P^w, Q^w, k^w1, k^w2)$, relative to variable assignments γ , we write $M, w, \gamma \models \phi$ to indicate that ϕ is satisfied in M at w by γ . Since the idea is that quantifiers range over individuals in $D2$ only, variable assignments map variables to the elements of the set $D2$ (instead of the whole set $D1$):

- $M, w, \gamma \models P(x)$ iff $\gamma(x) \in P^w$ (Note that $\gamma(x) \in D2$.)
- $M, w, \gamma \models P(k1)$ iff $k^w1 \in P^w$
- $M, w, \gamma \models R(t1, t2)$: the condition is defined analogously to the above.
- $M, w, \gamma \models \neg\phi$ iff for every v with $R(w, v)$, we have that $M, v, \gamma \not\models \phi$.
- $M, w, \gamma \models \langle \exists \phi \rangle$ iff for some v with $R(w, v)$, we have that $M, v, \gamma \models \phi$.
- The case of negation, disjunction, conjunction and conditional are the standard ones.
- $M, w, \gamma \models \forall x\phi$ iff for every $\delta \in D2$, we have $M, w, [x/\delta] \gamma \models \phi$.
- $M, w, \gamma \models \exists x\phi$ iff for some $\delta \in D2$, we have $M, w, [x/\delta] \gamma \models \phi$.

The initial world w of evaluation is, as was already hinted at, thought of as the world that represents the facts and objects of the story outside the fictional operator. For this actual world, it is natural to postulate that its first and second domain are the same. After all, in that world we wish to apply plain quantification over all that there is, fictions existing in that world included.

Let us now return to some example sentences.

Let $w = (D1, D2, P^w, Q^w, k^w1, k^w2)$ be the actual world, with $D1 = D2$.

1. *Object δ (that has no mass) is fictional.* This sentence has the simple form

$P(k1)$, where ‘ $k1$ ’ stands for the object δ without mass and ‘ P ’ is interpreted so as to be true of all fictional objects. The sentence expresses a true proposition at the actual world.

Notice that to establish that the sentence expresses a truth *in the actual world* is the artifactual way to state that δ does not exist: that is δ is not an independent object. Indeed, Thomasson argues in a forthcoming paper (*Fiction, Existence and Reference*), that negative existential claims should be understood as claims involving one determined ontological category.

Note also that this sentence is compatible with the following further sentence: *According to the model, δ is not fictional.*

Indeed the latter sentence has the form $\mathcal{F}\neg P(k1)$ and is true if for all accessible v , k^v1 fails to belong to the set of all fictional objects in v . This is in no way precluded by the actual truth of $P(k1)$.

Only at the actual world, that is, only when we are outside the scope of the fictional operator can we establish that δ is a fiction.

2. *The group of rigid motions included in the model of geometries with constant curvature corresponds to the experience of human motions.* This statement is not true according to the story (of the model). There is no necessitation (it might even be meaningless). However, it is *compatible* with the model. As long as the model does not lay it down that rigid motions are not human motion the story of the model leaves open the ‘interpretation’ or ‘realization’ in which the sentence is true.

3. «The sun is bigger than object δ .» Consider a model according to which this sentence holds. It is a sentence claiming that there prevails a relation between a certain non-fictional object (the Sun) and a certain fictional object (δ). Saying that the sentence holds according to the relevant fiction is to make a claim of the form $\mathcal{F}Q(k1, k2)$. In order for this sentence to be true, we must have for every accessible world v that $(k^v1, k^v2) \in Q^v$. There is no difficulty for this relation since in our framework both constants and relation symbols may take their interpretations from the second domain.

Let us see what we think we have accomplished, namely the articulation between artifactual theory and the fictional operator of the make believe approach. Coming back to Poincaré, the point is that idealizations are creations, as any other kind of constructions and artifacts. The fact that they are artifacts allows them to be proper denizens of our world. On this view, the constructive features of Poincaré’s arithmetic seem to build up the ontological structure on which conventions are to be performed.⁶

⁶ Though I continue to endorse the main claim of the present paper, written some years ago, nowadays, I think that a formalization of the underlying theory of meaning for the notion of *dependence* should be developed in the framework of Constructive Type Theory. In such a framework the objects constructed by scientific models are conceived as objects dependent upon a set of hypotheses. See Rahman / Redmond (2015).

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