Fictional Models De Novo and De Re

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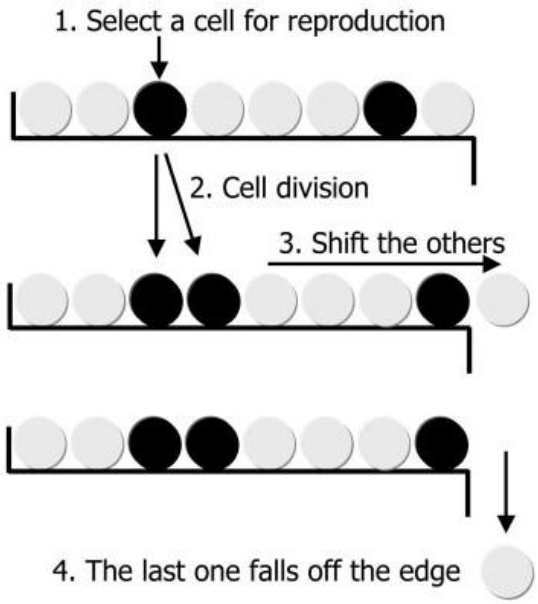
1. Introduction

In some philosophical contexts, appeals to fiction are motivated by an ontological agenda. When engaged in some type of inquiry, say mathematics, we appear to be committed to entities of a peculiar sort – number, sets, functions. An ontologically frugal philosopher comes along and suggests that the discourse should be seen as merely fictional, and not ontologically committing (Yablo, 2005). In discussions of modeling, fictions enter in a different way. The thought is that describing models as fictions provides the best interpretation of the *practice* of modeling, and not primarily a way of doing away with models. My discussion today in offered in this interpretive spirit, but it

also tries to recommend an ontologically modest way of developing the idea that models are fictions.

Let me begin by describing an example, which I take to be representative. It involves a model of the onset of cancer. Cancer often arises in small compartments within a tissue – for instance the little pockets in the colon known as "crypts" (Lauren, 2006). An important theoretical question is whether the architecture of the compartment affects the likelihood of cancer. One simple model that addresses this question is the "linear process model" (shown here in the picture). In the linear process model a compartment is described as a row of cells, a kind of production line in which cells pop in at one end and die at the other end. The model was introduced by Martin Nowak and colleagues, who have shown that this kind of architecture substantially reduces the chances of cancer.

Here's how Nowak introduces the model in a recent book of his: "One simple approach considers N cells in a linear array. At each time step a cell is chosen at random, but proportional to fitness. The cell is replaced by two daughter cells, and all cells to its right are shifted by one place to its right. The cell at the far right [dies]. The cell at the far left acts as a stem cell" (2006, 222). [Which just means it continually produces more crypt cells]



Nowak's Linear Process model

This stuff is pretty fascinating and quite important, but I am not going to talk about the science involved. I want to focus on the style of thinking and presentation. The linear process is way too simple to be a realistic description of anything that happens in an actual crypt, and Nowak is well aware of this. Real crypts have more stem cells, more than one "row" of cells and the "production line" is a lot less orderly. What Nowak is doing is offering a scenario to be entertained or imagined, not a description of real-world crypts. It is therefore tempting to treat the linear process as, in some sense, a fiction. Furthermore, as with fictional texts, we see here a kind of internal/external distinction. Statements within the model ("cells in the crypt are arranged in a row") have a different status from statements that treat the model as a model – such as "the linear process is the simplest possible model of crypt architecture"; or a comparative claim such as "crypts in the colon are well approximated by a linear process". The former are true or false only in a sense, only"according to" the model, whereas the latter seem true or false simpliciter. Such a difference between internal and external statements is often seen as a key feature of the discourse surrounding fiction (Contessa, 2010). There are further discursive

markers that point in the direction of fictions. Like Nowak, modelers often introduce models with locutions such as "consider…" or "imagine…" And especially in more reflective moments, they tend to speak of their work as depicting "artificial systems", "simplified scenarios" or "stylized versions" of the phenomena under study.

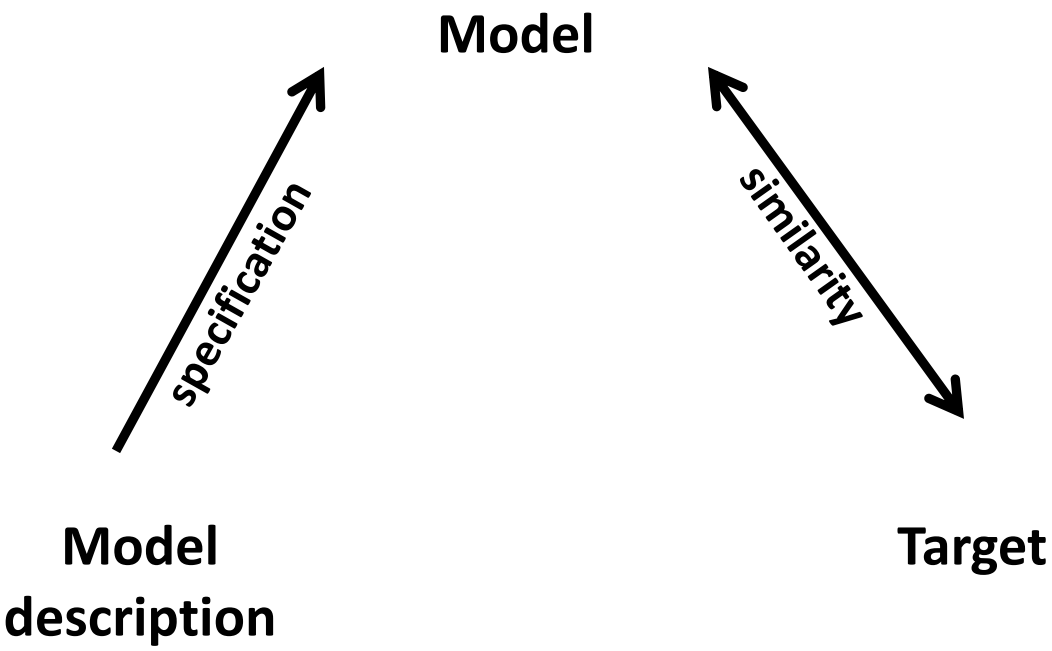
My presumption in this paper is that observations like these motivate the idea that modeling involves, in some sense, fiction and the imagination. I will also assume a broadly scientific realist outlook on which models often provide us with information about empirical target systems, including not merely good predictions, but also information about internal structures and processes that underlie observed phenomena – such as those underlying cancer, as in the example I started with. I'll describe one way of handling this idea, in which the model is regarded as a self-standing imaginary system, explored in its own terms and then compared with an empirical target system. Someone who holds this picture and is also a realist must take model-target comparisons quite seriously – as yielding information about the empirical world. But I'll argue that the notion of a comparison between an imaginary model and an empirical target raises serious problems, at least insofar as one wants to be a realist about modeling. In the final part of the talk I offer an alternative, which preserves the idea that modeling is a kind of fiction-making, but involves a lower-key notion of fiction. Rather than thinking of models as imaginary things, I'll suggest we think of them as imaginative descriptions of real-world things.

2. De novo Modeling

As our starting point we can take a view of modeling due to Ron Giere (1988; 2004). On this view, model-building involves, as a first step, an act of construction, whereby one sets up a model system, with its own structure and features. The model system can be investigated, to a large extent, independently of the empirical target system at which it ultimately aimed. The scientist specifies the model system and explores it in its own

terms. Once she has a good enough idea of how the model system works, she puts forward theoretical hypotheses. These are claims about model-target similarities: they spell out the respects and degrees in which model and target are similar to each other. In gathering support for theoretical hypotheses, we obtain information about the target. The epistemic product of modeling, on this view, is information about what the world is like; literally: to what extent it is *like* a model system.

We can represent the situation graphically:



(Adapted from Giere, 2

Now, one way of understanding the idea that modeling involves fiction is to take this basic structure from Giere and give it a fictionalist gloss. Peter Godfrey-Smith and Roman Frigg have offered views to this effect. The basic idea is that the thing at the top of the triangle, the model, is an imaginary thing. Theoretical hypotheses are statements about similarities between the imaginary model and its real-world target. This view has it that models are what we might call "de novo" fictions. They are created anew, as a self-standing construct. Now, suppose you are attracted to a de novo view, and also have a broadly realist outlook. Then comparing the fictional model to its real-world target is an important operation. A realist views modelers as aiming at, true comparisons.

(Presumably, they aim at true and substantial comparisons; but they need at the very least to be true).

Comparing a real-world target with an imaginary model seems, intuitively, to be a straightforward operation. But I think that on closer inspection it is not so obvious how such comparisons are supposed to work. In the next portion of the talk I'll look at several options for understanding the semantics of fictional claims, to see how they treat comparisons. The argument will be that there are some serious difficulties with this seemingly straightforward operation, at least insofar as such comparisons inform us about what the empirical world is like. I'll take a simple approach to similarity, treating it as a matter of sharing properties (Suarez, 2003). If John and Michael were both born in New-York City, then they are similar with respect to place of birth: they share the property of having been born in New York City. Some similarity relations are not exactly property sharings, but they are near enough for the purposes of my argument (Thomson-Jones, forthcoming, §3.3).

2.1 Fictions as games of make-believe. The first option I'll look at is that models are games of make-believe. Relying on the work of Kendall Walton, this option is especially appealing to naturalistically minded philosophers of science, as it avoids any appeal to imaginary objects. In this approach a fictional text is seen as a prop, a physical object that serves to prompt and coordinate the imaginations of readers. The prop is accompanied by so-called *principles of generation*, which are rules that specify what one ought to imagine in response to various features of the prop. Together, the prop and the principles of generation define a set of instructions for the imagination. The content of a fiction is then seen as what is to-be-imagined according to the instructions. In Walton's terminology, the prop and the principles of generation determine what is fictional in the game associated with a work of fiction.

In this framework, the only actual object is the prop. Assertions that have the surface appearance of being about a fictional object are taken to be pretend assertions that are

made appropriate by the prop and the principles of generation. It is most immediate to apply this approach to statements we make as readers, such as "Sherlock Holmes lives in 221b Baker St." In uttering such a sentence we seem to assert something of Sherlock Holmes. But on a make-believe view we only pretend to assert. The pretend assertion is appropriate because in the Holmes game, it is fictional that Holmes lives in 221b Baker St. As Roman Frigg has argued recently, we can transfer this analysis pretty much as is to "internal" modeling claims (Frigg, 2010). When a scientist working on the linear process model appears to assert that cells are arranged in a row, she is actually pretend asserting this, and her pretend assertion is appropriate because it's fictional in the linear process game that cells are arranged in a row.

In this way we can make sense of internal claims about fictional models. But since on the make-believe approach such models do not exist, how should we understand statements in which models are compared with real-world things? This is not a question that Walton spends too much time on. As far as I can tell there are three ways to go. One way is suggested by his discussion of non-existence claims such as "Sherlock Holmes does not exist". Such statements are made form an external perspective (as I called it earlier) from which one wants to deny that fictional characters and places are actual real things. Walton argues that these should be understood as setting up an unofficial game in which "it is fictional that there are two kinds of people: 'real' people and 'fictional characters'" (1990, 423). We can generalize the strategy to encompass comparative claims. Say we have a claim of the form: "A real crypt resembles a linear array in respects x,y,z." We can take this to be an invocation of an unofficial (or extended) game of make-believe in which there are both simple linear crypts and complex ones of the sort we find in humans. In the comparative claim there is a further component to our paraphrase, namely that in the extended game, it is fictional that the two sorts of crypts are alike in respects x,y,z. Such a reading of comparative claims is coherent. But, importantly, they turn out to be pretend claims, made appropriate by what is fictional in an unofficial game. So on this reading we cannot view comparative claims as carrying

information about real-world target systems. Not a situation a realist about the product of modeling will be happy with, I take it.

There's a second way of treating comparative claims, still within the make-believe framework. At one point in Mimesis as Make-Believe Walton considers the sentence "Sherlock Holmes is more famous than any other detective". He offers the following paraphrase: "There is a degree of fame such that no real detective is famous to that degree, and to pretend in a certain manner [in the manner in which one who says "Sherlock Holmes is famous to that degree" normally would be pretending] in a game authorized for the Sherlock Holmes stories is fictionally to speak truly." (1990, 414). The paraphrase is a bit complex, but the basic idea is this. The apparent comparison between the imaginary Holmes and real detectives is a composite of a true claim about real detectives, namely that none of them has attained a certain degree of fame d; *plus* an indication of what is fictional in the Holmes game, namely that Holmes *is* famous to degree d. Applying this to our comparative claim from before: "A real crypt resembles the linear process in ways x, y, z" is understood as saying that real crypts have properties x,y,z; *and* that it is fictional in the linear process game that crypts have properties x,y and z. Notice that, although we are not invoking an unofficial or extended game, we still have a problem of a similar sort to the one we had with the previous paraphrase. The comparative claim is seen as a combination of a statement about the real-world, and an indication of how to make-believe when playing the linear process game. So, again, the comparison is not really a claim about the properties shared by the imaginary thing and the worldly target.

The last option I can see within the make-believe framework, is suggested by Roman Frigg who, as I noted before, take models to be mere make-believe, in much the same way as Walton treats representational art**.** Frigg accepts that if one assumes that models are no more than pretend objects then there is a problem with comparing them to targets. But he argues that we can bypass this problem, by focusing on similarity relations amongst properties, rather than property bearers. Comparative statements, he says

"should be read as prefixed with a clause stating what the relevant respects of the comparison are, and this allows us to rephrase comparative sentences as comparisons between properties rather than objects… which are unproblematic in the current context (that is, the problems that attach to them have nothing to do with issues surrounding fictional discourse)." (2010, 263). Now, presumably Roman is appealing here to some notion of uninstantiated properties. The model, being merely an imaginary thing, does not instantiate properties. But by pretend-ascribing properties within a game we invoke the relevant uninstantiated properties, which are then available for comparison with the properties of targets. I am unsure how to understand this suggestion. Perhaps Roman can say more about this later. As it stands I tend to agree with a comment made by PGS, namely that the appeal to uninstantiated properties seems like a pretty high price to pay here (Godfrey-Smith, 2009). A major attraction of the make-believe view has to do with its low-maintenance metaphysics, where we forget about imaginary objects and deal only with mere make-believe. If making sense of comparisons requires embracing uninstantiated properties, then it seems like the metaphysical benefit of not having to worry about imaginary objects is offset by having to accept an ontology that includes uninstantiated properties. For this reason I regard the move to properties as an unattractive way of dealing with comparisons.

Perhaps there is another way of understanding comparisons within a make-believe approach. Barring that, I think we can say that if fictional models are mere make-believe, then comparative claims are very hard to make sense of, consistent with realism.

2.2 Fictions as abstracta The reason we have trouble with comparisons on the make-believe approach is that models are seen as merely imaginary. This suggests that maybe models ought to be seen as real objects. If imaginary models are actual, then clearly they are not concrete. But perhaps they're abstract entities. Amie Thomason has provided an extended defense of the view that fictional objects are abstracta. She takes them to be cultural artifacts (Thomason 1999; Thomason 2003), created by authors and dependent for their existence on copies of the work in question. In some ways, this is an attractive

view of fictions, and it does have some advantages in the context of models (Contessa, 2010). But comparative claims pose a serious problem for the abstract object view as well. Surely, such claims cannot be understood as claims about properties literally shared by abstract imaginary objects and concrete targets. Being abstract, they don't have many of properties that would figure in such comparisons – like mass, volume or genetic makeup. So clearly they cannot share such properties with targets. Now, Thomasson and others who hold that fictions are abstracta realize of course that we often speak of fictional characters as having concrete properties. But they account for this by appeal to make-believe, treating such statements as "Sherlock Holmes lives in 221b Baker St." as pretend assertions of one sort or another. Indeed, it seems that if imaginary objects are abstract then any ascription of concrete properties, either of the internal variety or in comparative claims will have to go via a make-believe. This means that, at least with respect to comparative claims, an abstract objects view reduces to a make-believe account, and faces the same sort of problems. Thus, construing models as abstracta does not, unfortunately, help with comparative claims.

2.3 Fictions as possibilia. A final option that I'll consider is that fictional models are possible objects – concrete but non-actual. David Lewis proposed such a view in the late 70s'. On Lewis' account the content of a fiction is understood as what is true in the possible world to which the fictional text directs our attention. The world in question is determined, according to Lewis, by a combination of what is made explicit in the fictional text, and background rules about how to fill in what isn't made explicit. [1] Now, unlike the previous options (make-believe and abstracta), on a possible worlds approach the semantics of comparative claims looks unproblematic. Possible objects have concrete properties (even if non-actual) and they can share these with actual target systems. So if

[1]. Lewis offers two main analyses which differ primarily in the background rules. 'Analysis 1' has the background rule: the possible world determined by the fiction is the one closest to the actual world, consistent with the explicit content of the fiction. Analysis 2 takes the background to be determined by: the possible world determined by the fiction is the one closest to the world as it is believed to be in the "overt" beliefs of the community to which the author belongs. Analyses 1 and 2 are not meant to be competitors. Each will be appropriate to different fictions, depending on the specifics of the work in question, the genre and other factors.

the imaginary model is taken to be a possible world, comparative claims are just claims about the properties shared by the relevant possible world and the actual world.

However, there are problems with the possible world account. Some are particular to the treatment of fiction; others have to do with the metaphysics of possible worlds in general. Briefly, one particular problem stems from the fact that possible worlds are maximally specific, whereas fictions, and models too, are indeterminate in many respects. This can generate some odd consequences. Another problem has to do with inconsistent fictions, a situation we find in modeling as well. Lewis offered a method of handling inconsistencies, but there is controversy over how well it works.[2] These problems are significant but perhaps not insurmountable. The more serious issues are general and well known. Many find an ontology that encompasses possible worlds bloated and mysterious. It's also far from clear how to reconcile it with broadly causal theories of knowledge and reference. Given all this, although possible worlds allow us to take comparisons seriously, I think the appeal to them is unattractive.

To summarize the discussion so far. On the de novo reading, fictional models are treated as standalone objects, and model-target comparisons are central. While appealing at first blush, it is hard to make sense of comparative claims in such a way that modeling provides information about what the empirical world is like, which is what a realist about model-based science would appear to be seeking. In other words, on the de novo reading it is hard to see how model-target similarities can bear the epistemic weight they are supposed to.

But I do think the observations we started with suggest that some form of fictionalizing is indeed going on in modeling. So in the final part of this talk I'd like to suggest a different way of handling this idea. Rather than thinking of a model as akin to a description of an imaginary thing, I suggest we think of it as an imaginative description

[2] See Currie (1900, §2.3) Byrne (1993), Hanely (2004).

of a real thing. Because I do not have a lot of time, I won't develop this alternative in detail. But I hope to make the main ideas clear.

3. De re Modeling

3.1 The de re reading. Recall Nowak's introduction of the linear process model. Nowak asks us to consider "N cells in a linear array. At each time step a cell is chosen at random, but proportional to fitness. The cell is replaced by two daughter cells, and all cells to its right are shifted by one place to its right. The cell at the far right [dies]. The cell at the far left acts as a stem cell" (Nowak 2006, 222).

One way to construe such a passage, as we have seen, is to treat it as a de novo specification of the imaginary linear process. But we might also take Nowak to be asking his readers to imagine *of a real-world crypt*, that it is a linear array with the specified properties. Call this the *de re* reading of model descriptions. Rather than thinking in terms of two steps, specification and comparison, the de re reading treats the model description as directly about its empirical target. What we have here is much like imagining, of oneself, that one were prettier, or a world-class athlete. A literary analogue is the historical novel. These are ways of make-believing, of the real world, that it differs in some interesting ways from actuality. On a de re reading, a model is a fiction in a fairly low-key sense. But it's still rightly regarded as fiction. The de re reading preserves the sense that modeling often involves a deliberate mismatch between models and reality. It explains why internal and external perspectives on a model differ. And it accounts for the tendency of modelers to introduce their work as offering "stylized" or "artificial" versions of empirical systems.

The de re picture does not encounter difficulties with comparisons. There is no appeal to comparative claims, because there is nothing, not even an apparent something, to compare the target with. All we have are claims about the target – some true, some false. However, two issues need to be addressed. The first concerns the compatibility of

the de re reading with realism; the other concerns its consonance with the practice of modeling. Let me say something about these issues in turn.

3.2 Realism. Van Fraassen defined realism as the view that "Science aims to give us, in its theories, a literally true story of what the world is like" (1980, 8). I think most realists would agree that this is at least an important part of their view. But on the de re reading, although modeling gives us descriptions of the world, these are often deliberately false. Indeed they may depart quite substantially from an accurate depiction of the target. So there seems to be a tension between modeling, read in the de re fashion, and realism. I agree that there is some surface tension, but I think it does not run deep.

The key here is that model-world mismatches are deliberate; they aren't mistakes. In introducing the linear process, Nowak knows full well that a real crypt differs from how the model depicts it. In reality, cells are not arranged in a row, there are multiple stem-like cells, there is mixing with a crypt and so on. It would not be hard for Nowak to give a more accurate model of the crypt, although this might not be the best way to study the effects of crypt architecture. A model that partly misdescribes its target can afford epistemic advantages such as making certain effects salient, or unifying diverse phenomena (Levy, forthcoming). And it can achieve such epistemic feats in part because those who make use of the model know which assumptions are true of the target and which are non-veridical simplifications.

So, although some aspects of a target will typically be falsely described in a model, modelers usually know which aspects these are and often *how* they are misdescribed. Indeed, this is one of the main reasons for drawing the analogy with fiction. But this suggests that a competent modeler, as well as a competent user of the model, can form beliefs in a discerning manner. To paraphrase William Wimsatt, they can use a false model as a means to true beliefs. So we can reformulate Van Fraassen's definition as follows. Realism is the view that science aims to give us, in its theories (or models) the means to form literally true beliefs about what the world is like. I think that the shift to

beliefs is actually truer to the spirit of realism. To be sure, it introduces a certain distance between the overt products of science and the beliefs that one can, and should, form on the basis of them. But this distance, I think, is a real feature of science. Knowing what to take seriously and what are simplifications, idealizations, or approximations, is an important part of a scientific training.

3.3 Compatibility with the practice? So far so good. But someone might object to the de re proposal by saying that it just seems to conflict with the practice of modeling. Much of the practice has the appearance of a de novo pretense, along the lines I described above. There is a delicate balance between accommodating the practice of modeling and providing a good philosophical picture of it. I think it's inevitable that some aspects of the practice will have to be at least slightly shoehorned if everything is to fit into one philosophical mold. With this in mind, let me make three remarks.

First, I think that when one looks at the practice with both the de novo and the de re readings in mind, one often finds that scientific texts can be interpreted both ways. The linear process passage is typical in this respect.

Second, in many cases what appears to be the first step in an indirect investigation is actually a case where there isn't yet a target. This can be a temporary situation, when a modeler defers the question of the model's applicability. Other times it is permanent, and then a model is more of an exploration of the relations between certain notions or magnitudes, or a kind of theoretical "proof of concept".

Finally, and here I come to the shoehorning part, I think in many cases we can take a model that is overtly presented in an indirect, de novo style and *translate it* into the de re idiom. You can see how to move between the two readings in the case of the linear process: one reading takes the linear crypt to be a simplified imaginary object that is compared to the real world. But we convert this into a simplifying imaginary description of an actual crypt. A claim such as "the linear crypt has one stem cell at the far left" can be read as saying something like: "suppose a real crypt has one stem cell, at the far left"

etc. We can do a similar translation with a case like the lotka-volterra model of predator-prey interactions, which is often taken to be a paradigm of indirect, de novo modeling (Wiesberg, 2007). The Lotka-volterra model is often presented in textbooks (and by philosophers) as a de novo specification of two highly simplified animal populations, the one preying on the other. But it was initially conceived as a model of fish in the Adriatic and even when the target it is applied to is a generalized predator-prey system, it can be read as offering to view real-world predator-prey populations as if they were Lotka-Volterra style populations. In general, any model that has a reasonably definite target can be read as a de re pretense. This sort of translation will often be a redressing of scientific texts, but not a radical one. The redressing retains, I think, the main features of modeling that motivate the appeal to fiction: model-target mismatches, the difference between internal and external statements, and the ways in which modelers talk about their work. And it does so while allowing us to do without imaginary objects, real or apparent, and the associated puzzles concerning model-target comparisons.