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Ideal-Model Descriptions and Truth

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ABSTRACT: In scientific practice, we find ideal models that rely on a sort of idealization. These ideal-model descriptions are usually construed as distorted representations of some real system. As such, the ideal-model descriptions count as appeals to (scientific) fictions. Here, I present a category of ideal-model descriptions which – even though involving some idealization assumptions – are nevertheless true. These cases come out as puzzling though. On the one hand, they presuppose some misrepresentations of an intended target system; on the other hand, they are true of that target system.

KEYWORDS: Idealization assumptions – ideal-model descriptions – material implication – models – truth.

I dedicate this paper to Professor Pavel Cmorej
in occasion of his jubilee. I owe much both
to his professional work and friendship.

1.

Scientific models contain idealizations or, at least some of them do. Frictionless planes, infinite populations, fully rational economic agents and many other hypothetically assumed (idealized) entities figure as elements in scientific models. Such idealizations are usually construed as intended misrepresentations or distortions of reality (cf. Jones 2005). When embedded in scientific models they affect them alike: what a given model aims to represent is a more-or-less extensive departure from a target system due to the idealizations it contains. Idealizations appeal to ideal entities which have no real appearance in physical reality.[1] For instance, a model of a body rolling down an inclined plane includes an assumption of a frictionless plane, but a corresponding physical system which the model aims to represent involves only a geometrically imperfect plane with non-zero frictional forces.

For this reason, scientific models involving idealizations are sometimes said to be false representations of the target systems. Since according to the received view, idealizations are false descriptions of physical reality and, moreover, they are constitutive parts of (this kind of) scientific models, these models are then viewed as false representations of physical systems as well.

At the same time, it is a common practice to discern between scientific models on the one hand, and their descriptions (and other symbolic depictions such as diagrams, pictures, etc.) on the other hand (see Weisberg 2013, sec. 3.2). If we follow this distinction here, then it makes more sense to say that it is *the descriptions* of scientific models (containing some idealization assumptions) rather than *models* as such, that count as intended misrepresentations of physical reality.

In this short paper, I present a category of ideal-model descriptions which – even though containing some idealizations, that is, some deliberately false descriptions of an intended physical system – come out nevertheless true.

2.

It is useful to introduce a couple of notions which may be employed in characterizing scientific models or modelling practice respectively.

Scientific models are usually conceived as *model systems* of a sort. However, there is no common view on the ontological status of scientific models. Beside the category of concrete physical objects (like the scale models), it has

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[1] Different kinds of idealization have been identified in the literature (such as, *Galilean idealization*, *minimalist idealization* or *multiple-models idealization*) – see, e.g., Weisberg (2007). Although they all are a sort of distortion of some target system, they differ in what factors they misrepresent and what function such an alteration plays in a modelling practice.

been suggested that non-physical model systems are either set-theoretic structures (cf. French – da Costa 2000), abstract objects (cf. Giere 1988) or abstract tools that scientists use in order to represent some physical features (cf. Giere 2004), or as imagined hypothetical entities which do not actually exist spatio-temporally but would be physical if they were real (cf. Frigg 2010; Godfrey-Smith 2010; and Toon 2010). According to a more pluralist view, models amount to a modeller's interpreted structures of different kinds (that is, concrete, mathematical and computational structures – see Weisberg 2013). Be the ontological candidates of model systems as they may, we do not need to take a clear stance on this ontological issue here. It will completely suffice to view scientific models as systems of a sort, i.e. objects of some kind standing in various relations (either imagined or not, abstract or concrete) to each other.

Model systems are often (though not exclusively) thought of as models of some other systems. These are usually called *target systems*. Target systems come in variety alike. They may be systems of some part of *physical reality* in general, or of some *data* in particular, or they may be models of some *theoretical system* or *theory* respectively.[2] However, in the case of ideal scientific models, idealization assumptions are, in general, specified with respect to some physical system. It is this category of target systems to which I will restrict my use of the term here.

Model systems play different cognitive roles with respect to target systems. One of them which has stood at the centre of current discussions is the *representation function*. Model systems represent some relevant features of the target systems though due to some idealization assumptions they misrepresent some other features of the target systems.[3] The question of the extent to which these other features are relevant for the study of target systems is methodologically important for an overall evaluation of a given model.[4]

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2 Even some target systems do contain idealizations or abstractions. However, this feature of some target systems does not affect the substantial point of the paper.

3 What I mean by 'relevant features' here is a collection of identified properties or relations of the target system's objects which, in a context of a modelling practice, play some explicitly specified theoretical role.

4 However, there is a plausible view of Strevens (to appear) who suggests that those factors of a target system which do not contribute to a causal explanation of the phenomenon in question are indeed the proper candidates for idealizations. For instance, in case of the model of Boylean behaviour of gases, assumptions such as – that the gas

I will not pursue in particular any conception of scientific representation here. The choice of any particular theory of scientific representation which has been currently on the market seems to be quite neutral to the problem presented here.[5]

In what follows, I pay an exclusive attention only to one kind of models – the ideal models. Simply put, ideal models amount here to models involving some sort of idealization. Along with ideal models there are ideal-model descriptions picking out these models.

3.

Before arriving to a subclass of ideal models and their descriptions which I find quite puzzling, it is convenient to characterize (and clarify thereof) the relation between ideal-model descriptions and ideal models as such.

Let us consider a case when we have some model system α and its corresponding (canonical) description "$\varphi(\alpha)$". What does it make the case that such a description is a true description of a given model? It seems that (at least according to a realist reading) the description is true simply by stipulation. For the description of a model system seems to be something very similar to stipulative definition. Such a model description either completely defines the model system with all its (relevant) properties and relations respectively, or it picks out some specific items from that complete list of the model properties and hence, characterizes the model truthfully though incompletely. In either

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particles do not collide or that they are infinitely small – do not make any substantial (causal) difference to the explanation of the Boylean behaviour.

[5] Suárez (2010, 94) distinguishes representation accounts with respect to two different dichotomies: On the one hand, there are theories of representation which differ on whether the representation relation (between a source and a target) is conceived as a primitive notion or as a notion reducible to a different notion (such as isomorphism or similarity). On the other hand, there are substantive accounts (usually linked to the reductive analyses) and deflationary accounts (see, e.g., Suárez 2004). Anyway, these distinct strategies do not make a difference to the problem presented here. For they still hold a line between what is (intended to be) represented and what is not. And this seems to be the very distinction behind the view that idealizations are just (a sort of) misrepresentations of reality. Nothing more is presupposed about the representation in this paper.

case, the model description is to the model system as a definition is to the entity (property, relation) being defined. As such, the model description cannot be false.[6] Otherwise, it is not a model description at all.

However, an anti-realist (or irrealist) may raise the following objection: The entities which a given model presupposes, such as frictionless planes or infinite populations of organisms, need not exist. In that case, the model description does not necessarily pick out objects and properties (relations) of the model system. Nevertheless, we are not left without a rejoinder to this worry: We may point out the fact that even an anti-realist of the "make-believe"–camp who construes model systems as hypothetical imagined entities does identify them (both, cognitively and linguistically) via the appropriate model descriptions. Hence, even for an anti-realist of that sort, the model descriptions are indispensable for imagining that model system. In fact, the descriptions of the model system serve as props in the game of make-believe. They faithfully describe what should be assumed or imagined at the level of a model system in order to get some knowledge of the target system (cf. e.g. Frigg 2010).

For that reason, when a model description involves an idealization assumption such as "There is a frictionless plane", or "There is an infinite population of organisms of kind *K* at place *P*", it is not the case that such an assumption is a false description of an intended hypothetical model system of bodies rolling down an inclined plane or of the model's populations. Contrariwise, it is a true description of the model system in question, be that model construed realistically or anti-realistically.

So when we say that a model description is a false description or misrepresentation, a reasonable interpretation is that we think of the description's falsity

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6 My view is in accordance with Giere's (1988) original understanding of the model descriptions. See also Weisberg (2013, 31-39). However, an anonymous referee pointed out to me that since the stipulative definitions are rather a kind of performative speech act which is neither true nor false of the entity being defined, then, strictly speaking, the model descriptions are neither true of the model system. I completely agree that at the level of speech acts, the stipulative definitions are not a sort of assertions about the model systems. However, since the model descriptions stipulate what elements a model system consists in, they truly describe what is constitutive for that model system. For a speech act distinction between stipulative (performative) and descriptive definitions, see Zouhar (2015).

with respect to a target system of some specific kind. For instance, the description "There is a frictionless plane" is not true of a (any) concrete physical target plane.

4.

It could seem that any model description which involves an idealization assumption (which is false of a given target system) is therefore a false description of that target system. However, this does not hold in general.

First let me point to an example of an ideal-model description which complies with the received view according to which such ideal-model description is false of a corresponding target system. I choose a partial description of Bohr's model of hydrogen as a suitable illustration of this idea (based on Thomson-Jones 2005). Simply put, Bohr's model assumes that a hydrogen atom is comprised of two particles, a proton and an electron. Beside other properties of the hydrogen atom ascribed by that model, the model takes for granted that a lighter electron moves around a proton in circular orbits. This ideal assumption about circular orbits of electron is clearly false. If we express such a partial ideal-model description in a more formal way, we can clearly see that this scheme may be generalized in a straightforward way to other cases of false model descriptions as well:

> For any x, if x is a hydrogen atom, then x comprises of two particles – a proton y, and an electron z – and z moves around y in circular orbits (and F(x)).

Or in general:

$$(\forall x)[C(x) \rightarrow (I(x) \land F(x))]$$

where "C(x)" stands for a condition which is satisfied in the target system (such as being a hydrogen atom) and where "I(x)" stands for one or more idealization assumptions which are literally false of the target system (and where F(x) is a possible shorthand for other possibly true conditions). As such, the ideal-model description of Bohr's model of hydrogen comes out false (of the target system) since its antecedent is true while the consequent is false (due to the falsity of at least one ideal assumption). This example is easily generalizable to other model descriptions having the logical form of material implication and such that though the antecedent is true of the target system, the consequent is false due to some idealization assumption.

Of course, there are other more straightforwardly false categories of partial ideal-model descriptions (of the target system) such as "There are frictionless inclined planes" or some such. All these cases comply with the view that the model descriptions which comprise some idealizations with respect to some target system, are literally false of it.

Now consider a case when we have a complete or partial ideal-model description "$\varphi(\alpha)$" such that its logical form is that of material implication and that an idealization assumption it contains appears in its antecedent. For instance, let's have a description: "If *x* is an object rolling down a frictionless inclined plane, then *x*'s distance travelled down the plane is proportional to t^2." For such a description to be true of the target system it completely suffices to have its antecedent false. In other words, that description is true both due to its logical form ('material implication') and the fact that there is no frictionless plane through which an object could move along.

Again, we can generalize this particular example of a true ideal-model description to other cases that satisfy the following condition:

(True Ideal-Model Description – "TIMD")
Let "$\varphi(\alpha)$" be a complete or partial ideal-model description having the following logical form: $(\forall x)[(I_1(x) \wedge \ldots \wedge I_n(x)) \rightarrow F(x)]$, where for $n \geq 1$, $I_1(x), \ldots, I_n(x)$ is some (simple or complex) idealization condition which is individually false with respect to an intended target system and let F(x) be a placeholder for some property- or relation-ascription, or for some functional relation $f(x) = y$ which may be true or false of a given target system.

If there is a model description satisfying (TIMD), then such description is true despite the fact that its idealization condition(s) are misrepresentations of (some part of) the target system if taken separately.

Moreover, it would be a logically straightforward extension of (TIMD) to include at least one literally true condition among some literally false idealization conditions in the antecedent. Still such a description would be true due to the fact that its antecedent (conjunction) is false.

Given the definition of (TIMD) condition, we can arrive at a definition of a complete ideal-model description that is both, idealized and true:

(Complete True Ideal-Model Description – CTIMD)
Let "$\varphi(\alpha)$" be either a complete model description of the form "$(\forall x)[(I_1(x) \wedge \ldots \wedge I_n(x)) \rightarrow F(x)]$" or a conjunction of all partial ideal-model descriptions of the form "$(\forall x)[(I_1(x) \wedge \ldots \wedge I_n(x)) \rightarrow F(x)]$". Let $I_1(x)$, …, $I_n(x)$, where $n \geq 1$, be some idealization condition which is individually false with respect to an intended target system and let $F(x)$ be a placeholder for some property- or relation-ascription, or for some functional relation $f(x) = y$ which may be true or false of a given target system.

Then any ideal-model description which satisfies CTIMD is true of an intended target system. In other words, even though there is a description of such highly idealized model system which, individually, contains some false assumptions about the target system, as a complex description it comes out true of the target system. However, this seems to be at odds with the view that idealized model descriptions provide a distorted picture of physical target systems. Put differently, there are ideal-model descriptions which are both, (partial) misrepresentations (or distorted representations) of a target system and, at the same time, true descriptions of it.

It seems quite puzzling that we have distorted descriptions of physical reality which we have good reasons to treat as literally false, though they in fact come out true given their logical form and satisfying an extralogical condition (of having an idealization condition in the antecedent). Be that as it may, we've come to an interesting conclusion: the notions of truth and misrepresentation are not mutually exclusive. We clearly have misrepresentations of some target systems which are nevertheless true. In addition, if these misrepresentations are taken as fictional statements, then there are fictional statements which are true of the target system.

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