philosophies

MDPI

Article

The Problem of Differential Importability and Scientific Modeling

Anish Seal

Department of Sociology, Philosophy, and Anthropology (SPA), University of Exeter, Exeter EX4 4PJ, UK; as1923@exeter.ac.uk

Abstract: The practice of science appears to involve "model-talk". Scientists, one thinks, are in the business of giving accounts of reality. Scientists, in the process of furnishing such accounts, talk about what they call "models". Philosophers of science have inspected what this talk of models suggests about how scientific theories manage to represent reality. There are, it seems, at least three distinct philosophical views on the role of scientific models in science's portrayal of reality: the abstractionist view, the indirect fictionalist view, and the direct fictionalist view. In this essay, I try to articulate a question about what makes a scientific model more or less appropriate for a specific domain of reality. More precisely, I ask, "What accounts for the fact that given a determinate target domain, some scientific models, but not others, are thought to be "appropriate" for that domain?" I then consider whether and the degree to which each of the mentioned views on scientific models institutes a satisfactory response to this question. I conclude that, amongst those views, the direct fictionalist view seems to have the most promising response. I then utilize this argument to develop a more precise account of the problem of differential importability, and ultimately offer a more general and less presumptive argument that the problem seems to be optimally solved by justifying comparative evaluation of model-importabilities solely in terms of comparative evaluations of what I characterize as models' "holistic" predictive success.

Keywords: ontology of scientific models; importability; differential importability; fictionalism; abstractionism; realism; nominalism

Citation: Seal, A. The Problem of Differential Importability and Scientific Modeling. *Philosophies* **2024**, *9*, 164. https://doi.org/10.3390/philosophies9060164

Academic Editor: Marcin J. Schroeder

Received: 17 September 2024
Revised: 20 October 2024
Accepted: 22 October 2024
Published: 26 October 2024

1. Introduction

What, in science, is a model? In general, scientific models are thought to be devices possibly conducing the application of scientific theories to parts of reality [1]. Scientific theories are thought to describe models such that knowing the properties of models becomes "surrogate" for scientifically knowing those of reality. Philosophically, things can be stated in clearer terms [2]. Philosophers of science have given precise, but conflicting, answers to the following questions:

i. "Are there such things as models?"
ii. "If models exist, what sort of things are they?"
iii. "How do models relate to the reality science accounts for?"
iv. "On what grounds does one import knowledge of models as (scientific) knowledge of reality?"

At least three accounts of scientific models could be distinguished in terms of their responses to i–iv. We now discuss the responses these accounts seem to have for the above questions. For the entirety of this essay, I shall be concerned only with theoretical, as opposed to physical, models believed to be used in science. Also, while speaking of models, I intend to speak of model-systems described by model-descriptions [1].

2. Abstractionism About Models: Are Models Abstracta?

Some [4,5] have proposed that scientific models are abstracta, or abstract entities. This proposal is not easy to delineate, in part, because the notion of abstracta is difficult

to characterize. What is an abstract entity? Since Plato's time, at least two competing accounts of abstracta have been defended by philosophers [6]. One view is that abstracta are transcendental—necessarily devoid of spatiotemporal properties. Another view is that abstracta are immanent—capable, in principle, of having some well-specified spatiotemporal properties. In fact, abstractionism about scientific models seems to endorse a transcendentalist picture of abstracta. So, I assume, in what follows, that abstractionism about models in science posits such models to have no spatiotemporal properties at all. Hence, scientific models lack such ordinary spatiotemporal properties as those of being massive, being heavy, being an hour long, etc. Abstractionists, however, believe that scientific models "represent" our concrete world of ordinary spatiotemporal entities. Representation, furthermore, of reality by models consists in their similarity to the reality they seek to represent. It is by dint of this similarity that knowing about these models is usually deemed sufficient for "scientific" knowledge of reality. Hence, the abstractionist thinks that (ai) there are such things as models, (aii) models are transcendentally abstract, (aiii) models represent reality by virtue of being similar to it, and (aiv) one imports model-knowledge as scientific knowledge of reality because models are similar to reality. Note, however, that the notion of similarity induced in abstractionist views is not univocal—different ways of characterizing this notion induce different abstractionisms about scientific models.

3. Fictionalism About Scientific Models: Are Models Fictions?

There exists a broad conception of scientific models as fictions [7]. What differentiates two prominent strands of this conception is a distinction made between two sorts of fiction—between what I shall decide to call "entitive" fictions and "non-entitive" fictions. Entitive fictions are fictional entities, i.e., entities whose actual existence is fictional. Entitive fictions, like Sherlock Holmes, fail to actually exist. There is a further distinction between extreme and moderate entitive fictionalists. Extreme entitive fictionalists, like Alexius Meinong, hold that entitive fictions are not only actually non-existent, but non-existent simpliciter. Sherlock Holmes, on this account, exists neither actually nor possibly. Moderate entitive fictionalists are disposed to contend that entitive fictions, while actually non-existent, may manage to exist as mere possibilia. Sherlock Holmes, despite not existing in our actual world, may exist according to moderate entitive fictionalism in a merely possible world—a possible world distinct from the world we actually inhabit. According to both moderate and extreme entitive fictionalists, however, the actual existence of entitive fictions fails to be obtained. Hence, on entitive fictionalist accounts of models, scientists are portrayed as talking about entitive fictions when engaging in model-talk. Models, on this view, are entitive fictions—they fail to exist as a matter of actual fact. Non-entitive fictions are actually existent entities conceived as possessing properties they do not, or cannot, actually possess. The fiction, as it were, in non-entitive fictions is the link of exemplification relating actual entities and properties they do not actually possess. For instance, while I actually exist and I actually possess the property of being a postgraduate student, my possession of the property of being an eco-terrorist from Jamaica is fictional because, as of yet, I am not an eco-terrorist from Jamaica. Therefore, my possessing the property of being an eco-terrorist from Jamaica is a non-entitive fiction, even if I am actually existent. A non-entitive fiction is a fictional relation of exemplification—between an actual entity and a property they do not actually exemplify. To exemplify a property is to have that property. There exist, in logical space, moderate and extreme versions of non- entitive fictionalism depending on whether the fictional relation of exemplification is required to be non-existent simpliciter or only actually non-existent. Fictionalists about scientific models may be indirect fictionalists or direct fictionalists about them. Note, then, that while only relations of exemplification are fictions on the direct fictionalist account, all sorts of entities (including the relata of exemplification) may be fictions for the indirect fictionalist.

Direct fictionalists hold that scientific models are non-entitive fictions. Toon [8] seems to espouse such a view, albeit with modifications and terminology of his own. Indirect fictionalists hold that scientific models are entitive fictions. Godfrey-Smith [9] seems com-

mitted to this strand of fictionalism. Models are held, by indirect fictionalists, to be entitive fictions in being non-actual entities similar, in some special sense, to a limited domain of the actual world—for instance, actual systems of predators and preys. Models are held, by direct fictionalists, to be non-entitive fictions in being non-actual relations of exemplification between actual things and their non-actual properties. Indirect fictionalists about scientific models hold that such models "represent" actual reality by being similar to the latter. Again, similarity is to be seen as the ground, as it were, for our importing knowledge of models as scientific knowledge of reality. This notion of similarity is to be distinguished from the abstractionist notion thereof. More on this shortly. Most direct fictionalist accounts of scientific models actually hold that there is no model in any "substantial" sense. Hence, according to direct fictionalism, one is to think that "model-talk" fails to inflate our default actual ontology with additional entitive fictions or abstracta. Direct fictionalists, as a matter of fact, ontologically deflate scientists' talk of models. Though they think models are non-actual exemplification links, they are, in fact, reluctant to concede the same reality to such links as they do to, at least, the relata of actual exemplification links. Hence, as a matter of fact, the ontology of direct fictionalists excludes the existence of non-actual exemplifications, and thus they remain extreme non-entitive fictionalists. A moderate non-entitive fictionalism about models where non-actual exemplifications have existence seems to be unrepresented in the literature. Nonetheless, we assume for our purposes that direct fictionalists are extreme non-entitive fictionalists. The responses to i-iv, as seemingly provided by direct and indirect fictionalists, are noted below:

Direct Fictionalism:

i. (Answer to i): There are no such things as models.
ii. (Answer to ii): The question has a false presupposition.
iii. (Answer to iii): (ditto (Answer to ii))
iv. (Answer to iv): (ditto (Answer to ii))

Indirect Fictionalism:

i. (Answer to i): There are such things as models.
ii. (Answer to ii): Models are entitive fictions.
iii. (Answer to iii): Models represent the reality science accounts for by being similar to the latter.
iv. (Answer to iv): Model-knowledge is imported as scientific knowledge of reality because models resemble reality.

4. Importability and the "Problem" of Differential Importability

In practice, scientists seem to choose among models with which to represent a limited portion of reality. In principle, a given domain of reality may be represented, more or less accurately, by more than one scientific model. For instance, the Newtonian model of the solar system is a model-system that helps theories of orbital motion get applied to planets in our solar system. The degree to which we remain justified in importing knowledge of the Newtonian model as "scientific" knowledge of our solar system, I decide to call its "importability" relative to our solar system. Now, while we use this particular model, in some instances, to represent our solar system, it remains a possibility that some other model, say "P"—in which entities that orbit are not perfect spheres but perfect cubes—could have been utilized for such representation. In principle, it might turn out that P is more or less importable than, but not equally as importable as, the Newtonian model relative to our solar system. The problem of differential importability is the problem of accounting for the difference in importability between different models of a given domain. An adequate response to this problem will involve answering the question: "What makes a given model more or less importable than other models relative to some portion of reality?" The problem of differential importability is a "problem" because it is unclear how one may cogently (a.) account for model-importabilities, or (b.) differentiate between model-importabilities, especially when models are posited to be abstracta or entitive fictions. Note that both abstractionists and indirect fictionalists posit that a model

must represent reality. This is clear from how they answered iii. Hence, they are opposed to instrumentalism about models. The worry, as we will presently see, for the abstractionist and the indirect fictionalists is their seeming failure to ward off such instrumentalism in trying to accommodate accounts of (differential) model-importabilities.

5. Differential Importability and Abstractionism About Scientific Models

If the abstractionist account of scientific models is true, there seem to arise difficulties in accounting for the phenomenon of differential importability. In the abstractionist view, model-systems are abstract structures. Given that models are abstract structures, the abstractionist proceeds to characterize "similarity" between such structures and the reality they model in terms of "formal" relations like isomorphism. Hence, different degrees of similarity between model and reality are accordingly interpreted as different configurations of these formal relations. So far, things remain unproblematic. The question now arises: "What justifies the employment, in science, of one abstract model "at the expense" of some other abstract model?" Saying that they have different degrees of similarity to the target domain is to say, simply, that they are distinct models. But that difference was granted, to begin with. Hence, relations of resemblance, in whatever formal sense, that an abstract model has to really seem, in and of themselves, to provide inadequate explanation for our choosing that model instead of other models. While it is granted that similarity between model and reality is responsible for representation, our question is about what makes a representation more acceptable than others. Under what conditions would we be justified in importing more about reality from a model A than from some other model B? The actual test, it seems, of the importability of models in the sciences concerns the nature of predictions that result from the act of importing. The Newtonian model, as it stands, may be said to have adequate importability because importing from it has resulted in reasonably successful and accurate predictions. This seems to imply that predictions induced by a model are "wholly" responsible for its degree of importability. If importability can be accounted for by predictive strength, what, then, is the role of similarity in representation, and why bother about representation? Why require a model's representation of reality for surrogating model-knowledge as knowledge of reality when predictive yield itself seems to justify this surrogacy? In response, the abstractionist can rhetorically ask, 'Is one still not obliged to make the models "about" reality?" The rhetoric fails, however, to make its point because it is not obvious that models must be about reality. That lack of obviousness is what paves the way for instrumentalism about models. Since abstractionists posit that models represent reality, they are obliged, it seems, to combat such instrumentalism. Perhaps a more constructive response from the abstractionist would involve deflating "representation" by rendering representation a matter merely of "definition". For an abstract model to represent reality, then, is for the model to be defined "as" reality, keeping its predictive profile in sight. That is, it is stipulated that the model "is", for the purposes of science, the relevant portion of reality. So, in model-talk, the abstractionist would contend, scientists talk about abstract structures defined "as" the portion of reality that we want to know "scientifically". By doing this, the abstractionist earnestly hopes to carve out a place for a model's representation of reality. But, on this stipulative account, models are not even related to reality "intrinsically", but are made "extrinsically" to be so. In this context, note that the similarity of the model to reality does not "obtain", but is "manufactured". Hence, this "stipulative" tack strongly induces an instrumentalist mood in scientific discourses because models and the theories they are described by seem to be mere black boxes, which, for reasons unknown to us, get things right about reality whenever we stipulate that models "are" some portion of reality. But this seemingly leads to more severe problems since the practice of defining abstract models as "concrete" chunks of reality seems to trespass key definitions in metaphysics and well-entrenched laws of logic. The only reply that appears to be available at this point to the abstractionist is that her definition is to be taken with a pinch of salt—that is, as mere make-believe and in an instrumental spirit. This, however, takes the abstractionist position too close to that of the direct fictionalist who views "model-talk" to involve acts of

make-believe (albeit not necessarily in any instrumental sense). Hence, the abstractionist view of models seemingly struggles with making sense of model-importabilities and ipso facto, with making sense of "differential importability".

6. Differential Importability and Indirect Fictionalism About Scientific Models

Indirect fictionalists about scientific models have problems with characterizing the legitimacy of the very act of importing model-knowledge as scientific knowledge of reality. For indirect fictionalists, models in science are entitive fictions that "represent" reality by being, in some sense, similar to the latter. How do we spell out this notion of similarity? What makes model-earth similar, as it were, to actual earth? In light of our previous discussions, we first discern whether the similarity is a matter of stipulation or not. Stipulation will again invite the same worries that apparently mar any case for abstractionism. One way in which indirect fictionalists seem able to evade the stipulation-worry is by not requiring that models be "abstract" counterparts of a concrete reality. Entitative fictions, as mere possibilia, could well exist concretely, were they to exist actually. Their status as mere possibilia can even be concrete in that they may exist concretely, i.e., not as mere abstracta, in some merely possible world. Hence, defining, for purposes of science, entitive fictions "as" actual entities does not invite metaphysical or logical illegitimacy. However, other worries remain about instrumentally stipulating entitive fictions as actual realities. Now, one way in which indirect fictionalists seem able to comprehensively evade stipulation-worries is by holding that entitive entities, unlike abstracta, can resemble actual concreta just like any two actual concrete objects may be said to resemble each other. So, merely possible John may differ from actual John only in owning exactly one more Rolex than the latter. Merely possible John and actual John are similar modulo the number of Rolex timepieces owned. Indirect fictionalists, thereby, have the resources to straightforwardly contend that models-qua-fictions resemble targeted domains of reality and, in that sense, represent the latter. However, the fact that the importability of fictional models seems, given the actual practices of science, to be located in the predictions afforded by "use" of such models seems to counteract this relative advantage of indirect fictionalism over abstractionist views. The indirect fictionalist can, perhaps, say that whereas predictive strength of models determines and explains the importability of models, insofar as representing reality is concerned, entitively fictional models can represent reality by being similar to it. This proposal, however, introduces a dilemma. In situations where we have entitively fictional models A and B of some targeted domain T, such that A is more similar to T than is B, but B predicts phenomena in T far better than A does; which one of the models do we choose, and why? Choosing B, but not A, will undermine the "value", as it were, of similarity and thereby, of representation, whereas choosing A, but not B, will undermine the value of predictive strength. The actual practices of scientists suggest that B will be chosen, for it yields better predictive outcomes. Hence, representativeness of models seems, in practice, to matter less than their importability. This again paves the way for instrumentalist conceptions of models because their representing reality seems to not matter much. Even if models are described as utterly different from their target, their having an acceptable importability will save the day. This dilemma undermines the value of indirect fictionalism about models as a satisfactory explanation for both representativeness and importability of models. If the indirect fictionalist contends that she is happy to just have given an account of the representativeness of models but not of their importability, she is only pleading guilty, albeit happily, of having produced an incomplete account of scientific models. Any theory of models that posits the existence of models must attempt to make sense of, among other things, the vital phenomena of model-importability and differential importability. In seemingly failing to account for their importability, the indirect fictionalist also fails to account satisfactorily for the "differential importability" of models.

7. Differential Importability and Direct Fictionalism About Scientific Models

How do direct fictionalists fare in accounting, simultaneously and satisfactorily, for both differential importability and representativeness of scientific models? It seems much better than the other views considered thus far. For one thing, direct fictionalists about scientific models manage to evade the need for providing such accounts. As already noted, accounting for representativeness and importability of scientific models is important and makes sense only for "realist" theories of scientific models, i.e., theories that hold "model-talk" to be ontologically committing one to the existence of models. Surely, we do not rightly expect of a theory that posits the non-existence of models, some account of what those models could achieve only by existing. For direct fictionalism about models, "model-talk" is elliptical for "imagination-talk". That is, scientists, when they talk of models, are thought by such fictionalists to be talking not about entitive fictions or abstracta, but about fictional ways in which actual entities could have been—ways that are, furthermore, to be imagined. The onus is still upon direct fictionalists to explicate those aspects of "model-talk" that have to do, respectively, with putative representativeness and importability of what are "called" models. How, in this task, does the direct fictionalist perform? In this instance, she is open to claim that talk of the representativeness of what are called "models" in model-talk, is elliptical for talk of "invitations to imagine". When scientists direct us to consider something, say A, as a model of some target domain T, the direct fictionalist would propose that we are being urged to imagine, or pretend, or believe that the "description" of A is really a description of T. Furthermore, the direct fictionalist can account for talk of the "importability" of what scientists call "models', by proposing that such talk is elliptical for talk of whether our pretense, or make-believe act of identifying a model-description with the true description of a specific domain of reality, has yielded more, or less, accurate predictions. No inconsistency, dilemma, or stipulation- worry is seemingly induced by this manner of interpreting model-talk. More crucially, the talk of differential importability reduces, for direct fictionalists, to claims that our believing in distinct model-descriptions as true-descriptions of some given portion of reality, yields distinct predictive outcomes. Crucially, the direct fictionalists do not invite instrumentalist worries in accounting for all these features of model-talk, because for them there exists no model to be an instrumentalist about.

8. Solving the Problem of Differential Importability by Invoking "Holistic" Predictive Success

In the foregoing sections, I have attempted to portray how three ontological views of models—abstractionist, indirect fictionalist, and direct fictionalist—fare in mitigating the problem of differential importability. In the said portrayal, however, certain simplifying, or potentially questionable, assumptions were made regarding (A1) the full significance or "import" of the problem of differential importability, (A2) the conditions under which it is palpable and requires resolution, (A3) how generally it interacts with philosophical—as opposed to strictly ontological—views of models, and (A4) the philosophical prudence of constraining the discussion to (a possibly limited number of) de facto extensions of ontologies of models to the epistemology, or other philosophical facets, of the model-target representational relation.

Assumption (A1) implied that the problem of differential importability is "just" the infelicity of accounting for differences in model importability, given some construal of models as abstract entities or entitive fictions. Here, the claim had been that the nature of the representational link between model and target as is posited by certain defenders of abstractionism or indirect fictionalism about models turns out, in some sense, to be both insufficient and unnecessary justification for judgements of comparative, hence differential, importability of two or more models of a given target system. This claim had been argued for under the assumption that ranking models based on their representational fidelity to the target can, in principle, disagree with their ranking based on the (reliable) success of the predictions they afford about the target. This assumption itself presupposes that

representation, if posited as a relation from model to target, "must" be understood in terms of "fidelity", "accuracy", or some minimal notion of "correspondence", as opposed to more heuristic idioms. The assumption (A2), to be precise, had been the above-mentioned assumption about comparative fidelity-success divergence and the correspondence notion of model-target relations of representation. Assumption (A3) had been the assumption the ontology of models has some uniquely special role to play in sustaining, or resolving, the problem of differential importability. This is apparent in the conclusion that has been drawn about direct fictionalism being relatively better placed than abstractionism and indirect fictionalism in evading the problem "by virtue" of eschewing realist notions of models per se. Assumption (A4) has been the view that the three ontologies of models under discussion are inseparable from the way in which some of their de facto proponents construe model-target relations, and where the relations are deemed representations, how they construe the significance of those representations. It is assumption (A4) that, by implying certain ontologies of models are as condemnable or tenable as are their extension to the nature of representations in a philosophical sense, sustained assumption (A3). This sustenance is appreciated by noting that the bulk, if not all, of the complaints against realist views of models in the context of their interaction with the problem of differential importability were really about the "function" that (some of) the views about model-target representational links they are sometimes de facto coupled with ascribe to those links.

In this section, I try to offer a more general, and methodologically reasonable, view than has been afforded by assumptions (A1)–(A4), of what the full significance of the problem of differential importability is and what the solution to the problem should consist of. First, to reframe the problem of differential importability, I distinguish between two "methodological" notions of representation. Models may, in a philosophical sense, be taken to "represent" their targets in at least two ways. In one of these ways, the model is taken to represent the target in an informational sense, affording more or less perfect epistemic access to the mechanisms, structure, or some other aspect of the target as they actually are. In the other way, the model is taken to represent the target in a functional sense, acting as a more or less dispensable constituent in the process of achieving some more or less epistemic "grasp" of the target. Since the grasp in question can admittedly be non-epistemic, a functional view of representation can, as it were, "black box" the degree to which the representation is "informational", and justify the inclusion of the notion in describing model-target relations due to how they might "facilitate" rather than "explain" some pragmatically contextualized predictive success derived from models. To be more precise about the informational/functional distinction, it is useful to distinguish between factive and non-factive representations. An informational representation is at least approximately "factive" in the sense that it is grounded by some more or less approximate "truth" about the object of representation. A functional representation need not be informational, and hence, it need not be the case that it is grounded by some more or less approximate "truth" about the object of representation. Here, "truth" is understood in terms of the correspondence theory, and the kind of things it concerns excludes what is already known, well understood, or taken for granted about the target "before" its representation by a model is affirmed. Now, given any articulable representational link between a target and its model, there are at least two distinct, methodological motivations behind affirming the link. Those concerned with preserving the realist notions that models expose truths about the target, and it is in this exposure that any of its more pragmatic successes find any explanation, find it methodologically convenient to parse truth in terms of the representational link, and hence construe the link as the locus of its "truthfulness" about, or "fidelity" to, certain aspects of the target. This view of representation in modeling has the consequence that models are at least approximately true of the target by virtue of representing truths about the target. This is what I term the informational view of model-target representation. Those more skeptical either of a model's capacity to always bring home truths about the target by virtue of "representing" truths about it, the very claim that models "represent", or the necessity, or possibility, of explaining the pragmatic success of a model in terms

of its representational or alethic feats, often find it equally convenient to construe the representational link as procedurally significant in the process, and given the particular aims of an act of "modeling", without affirming that the relation of representation they posit between model and target is also an informational representation. Here, resisting the latter affirmation may be an act either of opposing, or being neutral concerning, its plausibility or truth. This view—positing the facilitation of pragmatic success in modeling by models, but resisting any affirmation of whether the latter's representation of the target, if posited, is "informational"—I call the functional view of model-target representation. The distinction between informational and functional views of scientific representation has been highlighted by Chakravartty [10], who argues that while these two views are often portrayed as in conflict, they are in fact complementary. He describes informational theories as those emphasizing objective relations (such as similarity, isomorphism, and homomorphism) between models and their target systems. These relations provide epistemic access to aspects of the target as they actually are, which aligns closely with factive representations grounded in truth about the target [10]. By contrast, functional theories focus on the cognitive activities performed with models, such as interpretation and inference, and can therefore accommodate non-factive representations—models that facilitate understanding or predictive success without necessarily being true representations of the target system [10]. However, in the present context, the very same representation—whether an isomorphism or a stipulative interpretation—can be construed either as an informational representation or a functional representation, the choice being a methodological step in one's broader theory of what a certain sort, or all sorts, of model-target representation accomplishes, or must be taken to accomplish.

The problem of differential importability, in its full-fledged formulation, is the problem of choosing the justificatory basis for claims of the form, "M is (strictly) more/less importable than M′ in relation to T", where M and M′ are models of some unique target T. There are at least two distinct bases to choose from: the models' comparative pragmatic successes, including their attainment of arguably non-epistemic priorities, if any are recognized; and their representational "fidelity" to the target, assuming that the notions of representation presupposed in this comparison are adequately, mutually commensurable. Note that functional views of model-target representation that resist the affirmation of such a fidelity would be immune to the necessity of this choice. Since representation, as far as they are concerned with it—if at all they posit it—is subservient to the pragmatic success of models, functional views would be satisfied to utilize the comparative pragmatic success of the models (assuming the commensurability of the standards presupposed for this success) as justification for comparative importability claims. The problem of differential importability, then, is a problem for informational views of model-target representations, which, owing to their implication that the representation is not only not subservient to pragmatic success of models but is its very explanans, must decide whether representation and success are independent arbiters in comparing importabilities, and if so, which one ought to be privileged, and to what extent.

As may be gauged from the discussions in previous sections, the problem is quite acute when the comparative representational fidelity of models M and M′ to a common target T opposes their comparative pragmatic success. It seems plausible that the informational view, here, must respond with a satisfactory account of how, if representational fidelity explains pragmatic success, can the mentioned opposition occur. This is because, at least prima facie, it seems reasonable to suppose that if the possession of property A explains the possession of property C, then different degrees of C-possession would also be explained by different degrees of A-possession. But in the opposition between fidelity- and success-rankings under consideration, this intuitively plausible proportionality between the degree of explanans-occurrence and the degree of explanandum-occurrence is vitally missing. The informational view can however be taken to require simply that models' representational fidelity explains the fact that they are pragmatically successful to some positive degree, without also explaining the differences in the positive degrees of that success. Now,

suppose that a situation arises where model M has a greater predictive strength than has model M′, but according to some informationally construed notion of representation—say, a certain class of model-target isomorphisms—M has less fidelity to the target T than has M′. Suppose, furthermore, that the notion of representation is suitably tapered to the pragmatic uses intended for the models M and M′, so that it is the set of pragmatic purposes P commonly intended for both M and M′, that the sort of representational fidelity they are expected to have to T has been deliberately based on. Since, ex hypothesi, both M and M′ represent T—albeit to divergent degrees—in an informational sense, both are minimally pragmatically successful—albeit to divergent degrees—as already assumed. Also, note that a choice has to be made—if at all representational fidelity and predictive success are both considered at least minimally adequate guides to models' comparative importability—between the fidelity-ranking and the success-ranking, since neither agrees with the other. But if the fidelity ranking of M and M′ here is used as a justification for claims about their comparative importability, then predictive success will be eschewed in terms of (a certain notion of) informational representation. This would seem to be all well and good if the pragmatic context P from the very beginning only required a model with a degree of predictive success less than, and of representational fidelity more than, what the model—M′—with the lesser predictive success but greater representational fidelity has managed to offer. However, the issue here is that since representation is being assumed to be discernible as coming in lesser or greater degrees, there has to be some standard for, as it were, "measuring" those degrees. In other words, the notion of representational fidelity has to be an operable, measurable one, suggesting—prima facie—that the notion of (approximate) truth, the ground of that fidelity, has also to be equally operable and measurable. And this prima facie plausibility is very likely a conceptual triviality since what is at stake is not representation per se, but representational "fidelity"—something that seems conceptually grounded in some notion of correspondence not alien to any of the standard correspondence theories of truth.

Approximate or not, the operability of truth—presented within correspondence theories as both ultimate and unique—has been recently questioned by Hasok Chang [11], based on the premise that if ultimate truth, even in its approximate form, is straightforwardly uniquely operable, then so much difficulty or divergence would not have manifested in accounts of what exactly "correspondence" and hence "approximate correspondence" between truth-bearers and their subjects consist in. However, even if the operability and measurability of truth and its locus in a model are granted to the informational view and its realist proponents, problems seem to compound rather than subside. This is primarily because, if truth is operable, there have to be certain performable operations that would help discern its presence, and if it is measurable, the operations must involve some acts of measuring something. The question, now, is what could these measurement acts consist in, in the context of discerning the measure of a model's truth? Doubtless, there are various ways of measuring the truth of a representation—one of which is treating it as a prediction or hypothesis and discerning the measure of its confirmation by some standard of empirical evidence. If the informational view operationalizes truth in this way, it is extremely difficult to see how their comparative judgements about the differential (more/less approximate) truths of M and M′ are any different from comparative judgements of the models' predictive success (confirmation of hypotheses itself being—in all plausibility—a special case of predictive success) [2].

Before one hastens to conceive of how the informational view can still have truth operationalized without exhausting its operational base with empirical testing of predictions, they would do well to imagine the consequence of such a partially empirical operationalization for (standard) "scientific" realism. The realist reading of the informational view would probably not construe "partially" as applying to the class of truths upheld in science, but rather, the class of operations necessary for determining whether anything is a scientific truth. That is, the realist probably cannot afford to have a subset of scientific truths that are in no way established by predictive success in empirical settings, but may allow the testing

of some prediction to be only one of the operations to be used—as a matter of methodological necessity—for the discernment of something as a scientific truth. But this qualified, realist partiality is incompatible with informational representation being a desideratum independent from a rather holistic sort of predictive success. For, if informational representation is required in some context of modeling, the present qualification on the realist's part requires the "epistemic" justification for accepting such a representation to be necessarily composed of predictive success, at least partially. Even if such a representation is discerned as a true explanatory claim, or a means of truly understanding, the target—as opposed to rendering it merely predictable—the discernment would necessitate, by the present realist requirement that truth be necessarily discerned (even if partly) by successful predictions, predictive success not only in terms of the model being predictively successful enough for the truth of the representation to have a non-negligible prior probability, but also in terms of the representation's "content" being systematic and clear enough, for the generation of further predictions about the target "if" the prior probability of the representation is taken by the realist as enough "provisional evidence" for its (more/less approximate) truth. Hence, given that the realist does concede a necessary partial operationalization of truth in terms of predictive success, even such representational aims as the provision of understanding and explanation are ultimately accepted on the basis of how reliably successful the predictions derived from the model turn out to be.

On the other hand, understanding or explanation is itself often a desideratum in modeling, on the grounds that securing it is more likely to lead to more and clearer predictions—and the pragmatic aim of potentially more control over the target's behavior. Note, however, that in all of this, the ultimate decider of how importable a model is, even if its representations are parsed in informational terms, are the successful predictions derived from the model, or the potential to generate more such predictions: with both the actual success and the potential for success, co-constituting a holistic metric of predictive success. Note that even though truth, in the present context, is taken to be operationalized necessarily in terms of predictive success, nothing is said for, or against, the claim that truth—thus operationalized—coherently "explains" predictive success. This is because there might exist truth as correspondence that is necessarily discerned through empirical investigations and predictions but nonetheless grounds their nature, constraints, and success. It is just that we do not seem to know what the universally valid notion of correspondence is, and whether its discernment always needs empirical investigations. But a negative take on the latter question is not something the standard realist could plausibly afford—at least with respect to scientific truths—without introducing an unnecessary transempiricism into science. The point being made so far has been that the model's representations can still be construed in an informational sense—as grounded in (approximate) truth—while the partial operationalization of that truth in terms of predictive success is also taken to be sufficient epistemic justification for believing provisionally in that construal, at least until the belief somehow becomes infallible, and there arises to the believer's awareness and ultimate evidence for that infallibility.

To reemphasize a key suggestion from the foregoing discussions: the comparability of representation and truth (in the realist's sense) requires the operationalization of (at least) the latter, which in its turn involves the informational view of representations being held "at best" provisionally, on the basis of predictive success, and that any superficial privileging of representational "fidelity" rankings over predictive-success rankings in justifying comparative model-importability evaluations, or trade-offs between fidelity and success in those evaluative contexts, is fundamentally a justificatory process that solely concerns a holistic combination of actual, and forward-looking predictive successes: representations are provisionally true only if they, or their carrier's other representations turn out reliably predictively successful in actuality, or seem likely to turn out so potentially in the future. In other words, comparatively judging model-importabilities in terms of representational fidelity in a provisional sense justified by empirical, predictive success can be "described" entirely in terms of notions that exclude that of "truth" or "fidelity".

At this point, however, one might point to the realist's tendency of choosing between models in terms of "truth-conducive" properties, like simplicity, coherence, and suchlike. However, these properties are mostly appealed to when predictive success by itself fails to decide what is here being called comparative model importabilities. Hence, they are mostly subordinate to predictive success, and in line with this subordination, are not likely to be used to decide the tie between equally successful models if future capacities for prediction generation, and testing are felt to be highly compromised [3]. And it is highly implausible that models are ever designed, or should be designed, for one-time use. For instance, simplicity might or might not decide the tie, depending on the priorities concerning what sort of future predictions are planned for the models being compared at a given time—if simplicity makes future empirical success tractable, actionable and assessable more than its lack does so, the simpler of the models might be given the advantage. This view of theoretical or aesthetic virtues also affords an uniform, empirically grounded view of the modus operandi in what is often the complicated and debated nature of their use in theory- and model-choice. Given this view of truth-conducive virtues, the realist can still be fully described as concerned with a holistic, forward-looking sense of predictive success when deciding the comparative importability of models [4]. As emphasized by Schindler, simplicity serves as a legitimate epistemic concern not because it presupposes a simple world but because it tends to produce better predictive outcomes, which are valuable for the advancement of scientific knowledge [15]. Similarly, van Fraassen argues that the aim of science is not truth per se but empirical adequacy, and that theoretical virtues like simplicity and coherence play a crucial role in achieving this goal. These virtues help models align with empirical observations rather than directly indicating the truth of underlying reality [16]. The novelty in the argument of this section, however, is that empirical adequacy and predictive success can still be construed as a coherent, necessarily partial operation for the discernment of truth-qua-correspondence, which suffices as a "justification" for the same discernment, but in a provisional sense. Without loss of coherence, and unlike van Fraassen, nothing is really said here about whether truth-qua-correspondence also explains predictive success.

Realize that, over the argument being developed, the realist has been shown to stray so much from his epistemic confidence in non-provisionally capturing representation or truth "within science" that what was before framed as his dilemma between ranking of representational fidelity and ranking of predictive success should now only be seen as one between the ranking of "provisionally confirmed" representational fidelity and the ranking of predictive success. This entire argument runs quite analogously even if predictive success and representational fidelity never spoke against each other with respect to two or more models: that is, if it were always the case that M exceeded M' in terms of fidelity, if M exceeded M' in terms of success. Because even then, the ranking of fidelity would invite a need for its, and therefore truth's, operationalization. All of this very strongly seems to show that if comparative importability is to be justified on grounds of comparative "representational fidelity" at all, the closest one might get is to justify it on grounds of provisionally empirically confirmed representational fidelity, and hence, acknowledge the centrality, indispensability, and exhaustive involvement of judgements of comparative predictive success in justifying comparative model importabilities.

The above account of the problem of differential importability and how it becomes resolved has tried to show that even a realist position on the epistemology of models/modeling would be conceptually compromised if certain concessions are not made regarding the nature of representation and truth, and that some of those concessions strongly imply that the problem of differential importability is solved for both realist and non-realist construals of model-target representations, only if predictive success is duly recognized as the overriding and exhaustive justificatory basis for deciding comparative model importabilities. In developing the above account, one will note that the assumptions (A1)–(A4), that limited the scope and possibly the persuasiveness of the previous sections of this essay have all been discharged [5]. The originality of this essay is reinforced at least by its handling of truth in model evaluation. Unlike existing frameworks that consider predictive

success as one factor among many, this essay argues that truth is partially operationalized as actual empirical success, making empirical adequacy a provisional marker of truth. Additionally, it reinterprets truth-conducive virtues as elements contributing to prospective predictive success, thereby granting the realist a correspondence notion of truth based on philosophical grounds while offering a defeasible evidential basis rooted in empirical success. This nuanced approach fills a significant gap in the current literature [17–19], where empirical grounding and prospective success are often not given sufficient emphasis in realist evaluations. By integrating these elements, this essay offers a framework that aligns more tightly with the realist's commitment to truth, providing a holistic evaluative method that ties empirical success and truth as mutually reinforcing.

The argument in this section suggests that while the realist and antirealist alike should have the same *procedural* idea of model importability comparisons—namely, the comparisons of measured predictive successes—they differ in terms of what they think they are "ultimately measuring", and whether there is anything more ultimate than predictive success being measured. Plausibly, only the standard realist needs to think that there is something more ultimate being measured—albeit fallibly—namely, (more or less accurate) informational representation, or (more or less approximate) correspondence-truth. The argument has also assumed that the potential for predictive success to be subject to "underdetermination" by data is an issue at least prima facie orthogonal to the reasonableness of positing that success as an operationalization of representational fidelity or correspondence truth. This seems unproblematic because, if underdetermination plagues the importability-comparisons of incompatible, but more or less equally predictively successful, models, the realist faces the problem of discerning how a unique truth about the target can be (approximately) represented—in an informational sense—in incompatible ways. But this is not at all the problem that has been addressed in this section. The problem that has been tackled is that: *if* the (standard) realist both defends a unique notion of truth and intends us to take seriously his talk of "comparing" truth and informational representation, exactly what should his "procedural" understanding of comparing model-importabilities be? The answer to this question can be discerned, even if the realist's defense of unique truth with a unique operationalization fails on separate, independent grounds.

9. Conclusions

In this essay, I have, in two distinct, progressive steps, attempted to explicate the problem of differential importability and develop an argument in favor of solving it by invoking the notion of models' holistic predictive success. The intended novelty of this essay, in comparison to the many accounts that have discussed the issue of model comparison through a philosophical lens, is that it implies compatibility between realist notions of truth and representation and the need for the realist to still conceive of comparing model importabilities as fundamentally an exercise in reasoning about the comparative, holistic predictive success of the relevant models. Another intended novelty has been the essay's suggestion that the realist is compelled to conceive as much on the basis of what may plausibly be considered his own premise: that one is, in comparing model-importabilities, "comparing" the "degrees" of fidelity or truth possessed by the relevant models.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: No new data were created or analyzed in this research.

Conflicts of Interest: The author declares no conflict of interest.

Notes

1 The schematization of views on scientific model-systems that this essay follows is borrowed, in large part, from [3].

2 The claim that success in hypothesis testing involves predictive success is well-supported both empirically and philosophically. Mizrahi [12] empirically demonstrated that in scientific practice, predictive success plays a crucial role in hypothesis testing and confirmation, particularly in the life sciences and social sciences. His work shows that scientists frequently use inductive reasoning, such as predictions, as a basis for confirming hypotheses. Similarly, Salmon [13] emphasized the centrality of empirical success, particularly predictive accuracy, as a key factor in confirming the reliability of scientific theories. Predictive success is thus not merely a practical tool but a fundamental criterion in evaluating the epistemic value of models and hypotheses. On the face of it, then, this connection between hypothesis testing and predictive success seems to be a foundational concept in the philosophy of science, especially in discussions of theory confirmation and scientific realism.

3 Ref. [11] raises suspicions regarding the methodological coherence of utilising truth conducive virtues via the admirably pithy observation that if truth itself—considered as representation-reality correspondence—seems to elude a unique, universally accepted operationalization demanded by the standard realist, it is unlikely that truth-conducive virtues are somehow immune to an analogous failure to settle the issue (if they are taken to conduce truth as correspondence, that is). As will be noted, this observation, though incisive, is not a decisive defeater of nonempirical belief in uniqueness and operability of truth as correspondence: a belief that the realist is granted over the course of the present argument.

4 As Murphy, Currie, and Walsh [14] argue, the role of aesthetics in science is deeply intertwined with the epistemic and practical agency of the scientist. In their view, aesthetic preferences—such as simplicity, elegance, and clarity—are not merely incidental but are instrumental in generating successful experimental outcomes. "Good design in experiments," they claim, "can be understood in terms of how it generates aesthetically (and epistemically!) rewarding agency in scientists performing the experiment" (ibid.). This justification is pragmatic: the better the design (in terms of simplicity and elegance), the more accessible and reliable the results become. The authors show that this holds especially true for the intersubjectivity of experiments, where consistency across agents' experiences is crucial for producing stable sources of evidence (ibid.). This principle can be applied analogously to truth-conducive realist virtues like simplicity, coherence, and explanatory power. These virtues, much like aesthetic preferences, are pragmatically justified by their utility in producing reliable, successful models. Just as an elegant experiment enhances clarity and accessibility to phenomena, a simple and coherent model contributes to its **predictive success and its capacity to represent the target system effectively. In both cases, these virtues (whether aesthetic or realist) function as epistemic tools that improve the effectiveness and utility of the scientific practice. Murphy et al. emphasize that aesthetics are "geared towards generating aesthetic experiences and agential expertise" (ibid.), and in a similar way, realist virtues guide model selection to ensure that models are not only representative but also useful for prediction and explanation. Furthermore, Murphy, Currie, and Walsh (ibid.) argue that well-designed experiments "facilitate ongoing practical action" by the scientist, a notion that resonates strongly with how realist virtues are often defended in the philosophy of science. Simplicity and coherence, for instance, facilitate the ongoing practical use of models, enabling scientists to apply models across various domains with minimal adjustment, thus enhancing their importability. Similarly, much like an experiment's clarity can compel assent by producing clear, elegant results, a simple model can compel acceptance through its practical success in providing explanations and generating predictions. By drawing this analogy, one can see that just as aesthetic preferences in experimental design are justified by their epistemic productivity, so too are truth-conducive virtues in realism. These virtues enhance the epistemic and practical value of models, not because they adhere to some abstract ideal, but because they lead to pragmatically successful outcomes. In both experimental and theoretical contexts, the virtue is justified by its utility: simplicity and elegance (whether in design or in model structure) directly contribute to epistemic success, be it through clearer experimental results or through models that explain and predict phenomena reliably. Therefore, realist virtues like simplicity, coherence, and explanatory power can be viewed as epistemically justified in the same way as aesthetic preferences, by their capacity to guide practical scientific action. Note, however, that my account of how alethic or aesthetic virtues find justification in discerning comparative model importability is not invariably celebratory, but contextual. My claim is not these virtues invariably suffice to conduce experimental and predictive felicity, and hence find acontextual probative status in comparing importabilities, but rather that they are mostly used only when they do so: that is, a virtue earns that probative status in a particular case of comparison (mostly) only if the difference in the possession of that virtue foregrounds a difference in the felicity with which prospectively intended experimental and prediction-related operations on the model can be performed in the desired way.

5 Discharging assumption (A1): Initially, differential importability was constrained by views that strictly conceptualized models as abstract or fictional entities. The discussion has been expanded to consider how models function in practice, regardless of their ontological status. By demonstrating that the utility of models in scientific practice often transcends their ontological categorization, this section discharges the narrow focus of Assumption (A1) and shows that practical success in modeling is often independent from strict ontological classifications of models. Discharging Assumption (A2): The assumption that differential importability requires a solution rooted solely in the ontology of models has been reevaluated. By incorporating pragmatic considerations such as the applicability, coherence, and explanatory power of models, the argument shows that practical concerns can provide a robust basis for model selection and use. This pragmatic shift discharges Assumption (A2) by proving that ontological purism is less relevant than a model's operational success in explaining and predicting phenomena. Discharging Assumption (A3): This assumption posited that the problem of differential importability could only be resolved within the

confines of existing ontological frameworks about models. This section challenges this by arguing that the epistemological and practical achievements of models often outweigh their ontological foundations. By focusing on the results and impacts of models in scientific inquiry, rather than their theoretical underpinnings, Assumption (A3) is discharged, advocating for a more flexible and results-oriented approach in scientific modeling. Discharging Assumption (A4): Initially, there was an implied inevitability that ontological discussions about models would directly influence their philosophical appraisal in terms of representation. The argument to be developed will show that it is possible to discuss and evaluate models based on their epistemological roles independently of their ontological claims. This approach discharges Assumption (A4) by decoupling philosophical debates about the nature of models from practical assessments of their utility and success.

References

1. Frigg, R.; Hartmann, S. Models in Science. In *The Stanford Encyclopedia of Philosophy, Fall 2024 ed.*; Zalta, E.N., Nodelman, U., Eds.; Metaphysics Research Lab, Stanford University: Stanford, CA, USA, 2024; Available online: https://plato.stanford.edu/archives/fall2024/entries/models-science/ (accessed on 23 July 2024).
2. Bailer-Jones, D.M. *Scientific Models in Philosophy of Science*; University of Pittsburgh Press: Pittsburgh, PA, USA, 2009.
3. Toon, A. Imagination in scientific modeling. In *The Routledge Handbook of Philosophy of Imagination*; Amy, K., Ed.; Routledge: Oxfordshire, UK, 2016; pp. 451–462.
4. Giere, R.N. *Science Without Laws*; University of Chicago Press: Chicago, IL, USA, 1999.
5. Weisberg, M. *Simulation and Similarity: Using Models to Understand the World*; Oxford University Press: New York, NY, USA, 2013.
6. Zalta, E.N. Abstract Objects. *Rev. De Métaphysique Et De Morale* **1983**, *90*, 135–137.
7. Contessa, G. Scientific models and fictional objects. *Synthese* **2010**, *172*, 215–229. [CrossRef]
8. Toon, A. *Models as Make-Believe: Imagination, Fiction, and Scientific Representation*; Palgrave-Macmillan: New York, NY, USA, 2012.
9. Godfrey-Smith, P. The strategy of model-based science. *Biol. Philos.* **2006**, *21*, 725–740. [CrossRef]
10. Chakravartty, A. Informational versus functional theories of scientific representation. *Synthese* **2010**, *172*, 197–213. [CrossRef]
11. Chang, H. *Is Water H_2O? Evidence, Realism and Pluralism*; Boston Studies in the Philosophy and History of Science; Springer Science & Business Media: Berlin, Germany, 2012.
12. Mizrahi, M. Hypothesis Testing in Scientific Practice: An Empirical Study. *Int. Stud. Philos. Sci.* **2020**, *33*, 1–21. [CrossRef]
13. Salmon, W.C. Conflicting Conceptions of Scientific Explanation. *J. Philos.* **1985**, *82*, 651. [CrossRef]
14. Murphy, A.; Currie, A.; Walsh, K. Aesthetics and Agency in Experiments. Available online: https://philsci-archive.pitt.edu/id/eprint/23988 (accessed on 21 October 2024).
15. Schindler, S. *Theoretical Virtues in Science: Uncovering Reality Through Theory*; Cambridge University Press: Cambridge, UK, 2018.
16. Van Fraassen, B.C. Theory Construction and Experiment: An Empiricist View. *PSA Proc. Bienn. Meet. Philos. Sci. Assoc.* **1980**, *1980*, 663–678. [CrossRef]
17. Parker, W.S. Model Evaluation: An Adequacy-for-Purpose View. *Philos. Sci.* **2020**, *87*, 457–477. [CrossRef]
18. Bokulich, A.; Parker, W. Data models, representation and adequacy-for-purpose. *Eur. J. Philos. Sci.* **2021**, *11*, 31. [CrossRef] [PubMed]
19. Sullivan, E. Understanding from Machine Learning Models. *Br. J. Philos. Sci.* **2022**, *73*, 109–133. [CrossRef]