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BOOK REVIEW

James Nguyen and Roman Frigg: *Scientific Representation*. Cambridge: Cambridge University Press, 2022, 90pp., €21.23 (Paperback), ISBN: 9781009009157

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What is involved in something representing something else? The abstract to Nguyen and Frigg's excellent *Scientific Representation* states that the book will take up this question, although it is focused on epistemic representations less generally. The authors characterize epistemic representations as those entities that "afford information about their targets" (p. 6). It is then plain that the nature of scientific representation is a special case, even if it is unclear how they are distinguished from non-epistemic representations. Of course, not every epistemic representation is scientific; and some scientific representations do not afford information about their targets, and so would seem to be scientific but not epistemic according to the authors' characterization. Models and targets are characterized as systems related by the representation relation: models m_i, m_j, […] are systems that "tell us about systems in the world because they represent them" (p. 5), although this seems to render scientific representation as an explanans rather than an analysandum. The book ploughs ahead by reconstruing questions about the nature of scientific representation in terms of more tractable narrow questions like 'how do scientific models work?'. Of course, since not every scientific representation is a model and not every model a scientific representation, it is unlikely that scientific representations can be analyzed in terms of them without remainder. And even if every model were an epistemic representation, not all epistemic representations are models. Consequently, the through line is initially a little untidy. But none of this is a criticism of the authors, who do an excellent job of regimenting their particular conceptualizations of common terms; these general concepts are generally knotty for everyone, and the book ultimately does a nice job of untangling them.

Frigg and Nguyen's (2021) *Stanford Encyclopedia of Philosophy* (*SEP*) entry on scientific representation is a well-executed précis of the contemporary literature, and of their previous work on model-based scientific representations in particular—of which this *Element* is a more elaborate follow-up. Like the *SEP* entry, it offers an admirably clear survey of the central issues, and anyone interested in epistemic representations in scientific contexts will profitably gain from studying it. The book's organization is sectioned into four chapters.

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After delivering a helpful framework, the book surveys two dominant trends in the contemporary literature on scientific models and modeling—resemblance- and inference-based conceptions—and ends with a defense of the authors' preferred conception ('DEKI').

The opening chapter's first half introduces two models relied upon throughout the book: a concrete scale model of ocean liner propulsion, which will be a useful example for most readers, and an abstract mathematical model of a stunt car jumping a bridge on a film set, which might be less gripping given the book's audience. But other familiar examples are discussed en passant for effect, such as the San Francisco bay model of the Reber plan and the Phillips/Newlyn hydro-economic model of the British economy; and although some readers may be left wanting better examples of workaday models that are more central to bench science, those better examples often lead to stodgy discussion. Instead, the authors call upon examples of models that are easier to understand and that strike an admirable balance between synopsis and detail; and this, combined with their crisp prose, keeps the discussion nimble and moving forward fast.

The opening chapter's second half, which frames all subsequent content, repays close study. It consists in a compact taxonomy of three questions about how models scientifically represent their targets, followed by nine success conditions on answers to those questions. The authors reasonably advise readers not to conflate answers to the semantic question—deemed "most fundamental"—of how a model scientifically represents its target from the alethic question of how models become accurate scientific representations and the metaphysical question of what models are (pp. 7–8). Unclear, however, is why the third metaphysical question would not instead be the first and most fundamental question, given that answers to that 'model question' have implications for both the semantic and the alethic questions but not necessarily vice-versa.

Among the book's most valuable parts is the obstacle course set up at the beginning—i.e., the nine success conditions that Nguyen and Frigg levy on answers to the aforementioned three questions. The book helpfully summarizes this obstacle course in a figure, which is reproduced below (Fig. 1, p. 13).

Answers to the semantic question are said to be constrained by at least four conditions. Specifying what makes m scientifically represent its target t must not violate the principles (i) that most model/target representational relations are asymmetric ('directionality'), (ii) that some models only scientifically represent non-extant or even unrealizable possibilia ('targetlessness'), and (iii) that models allow reasoning about target behavior ('surrogative reasoning').

Intriguingly, the fourth condition ('misrepresentation') is variably characterized. It is not the principle that we must distinguish between inaccurate representation from representational inaccuracy, since no one fails to navigate that application of the content/property distinction. But it is characterized as the principle (iv) that models cannot be scientific misrepresentations unless they are also representations (p. 8); that answers must distinguish between misrepresentations and non-representations (p. 9); and that answers must not conflate representations with accurate representations (p. 10). Owing to its variable characterization, this plausible condition is worth exploring further. For instance, does the injunction also imply that we must not conflate representations with inaccurate representations, either? It is hard to see what could motivate denying the parity; but combining those principles dictates that we should not conflate representations with representations of any alethic value, which renders the condition toothless by reductio ad absurdum. Or does the

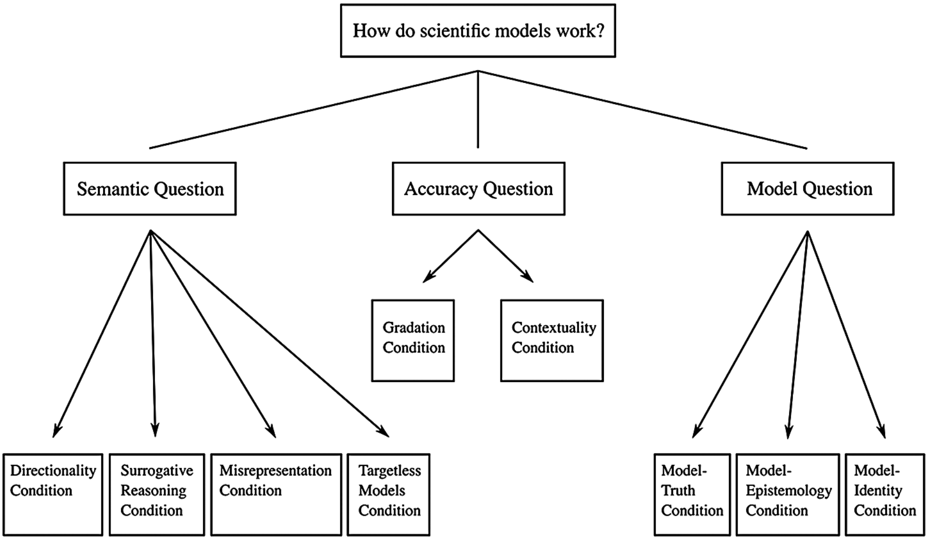

Fig. 1 Questions and conditions that an account of representation should attempt to answer, reproduced from Nguyen and Frigg (2022, p. 13)

injunction only imply, by way of parity again, that we also should not conflate misrepresentations with inaccurate representations? It is hard to see what could motivate denying any such analytic truth. Exploring further, does the distinction between misrepresentations from non-representations imply that entities failing to represent a target still are, or are not, representations of that target? The misrepresentation condition does not determine what would count as a good answer. Relatedly, an irreal target is still a target; if every misrepresentation is an inaccurate representation, and so a fortiori a representation of some sort or another, are we committed to treating "inaccurate" as an intersective adjective? Or are some maximal inaccuracies so grossly total as to render the adjective non-intersective, like 'counterfeit' or 'illegitimate'—much as an ill-formed formula is really no formula at all? Of course, space is limited in these *Elements*, and so the book does not explore these issues.

The book rightly distinguishes the semantic question from the alethic question. But it is fair to say that the misrepresentation condition binds them together in a way that raises doubts about conceptual priority; and the separation of that condition from the condition (v) that the alethic values of models to be scalar ('gradation') seems to be taxonomically arbitrary. Answers to the question about what confers representational accuracy also must allow (vi) that context modulates judgments of accuracy ('contextuality'). The third metaphysical question asks what models are—and presumably not in a merely conceptual way that swerves back into the semantic question. Another principle (vii) is that answers must state how claims made 'from within' models can be true or false ('model truth'). The book would have been improved from discussion of the nuances between this true-in-a-model condition and the previous conditions pertaining to accuracy-of-a-model. Answers are required to specify (viii) how one comes to have justification or knowledge from models ('model epistemology'), although it is unclear why this would be a success condition on answers to questions about what models are. The final condition is that answers must (ix) provide identity and individuation conditions.

The book's second chapter offers an illuminating critique of a canonical conception of model-based representation, according to which m represents t iff m either structurally ('morphism') or materially ('similarity') resembles t. Some familiar worries are initially canvassed: similarity is exceedingly cheap to establish, relevance is complicated, co-instantiation invites type/token problems, etc. The chapter then launches into a rundown of the ways in which answers grounded in resemblance unsuccessfully navigate the obstacle course specified in chapter one. Notably, resemblance conceptions are said not to meet the directionality condition because resemblance in general is reflexive and symmetric (p. 22). This raises a challenge: resemblance theorists need a non-stipulative condition that makes it the case that t resembling m is insufficient for t to be a model-based scientific representation of m. The book does not explore whether this challenge can be met. Another challenge is that resemblance-based answers are said not to meet the targetlessness condition. The authors are right that a targetless model is one that is neither similar to nor isomorphic with that target; for there is none. But anyone supposing both that all models represent and that some models are targetless also owes an answer as to what it is that targetless models represent. Or, if not all models represent, then resemblance theorists are no more backed into a corner than anyone else: a model failing to resemble a target that it does not have will just be a model that does not represent a target that it does not have. Or, if targetless models represent non-actual targets, then presumably resemblance theorists will have available to them the claim that an actual model represents its non-actual target just when it resembles its non-actual target. So, again, it is unclear whether there is a genuine problem, here. The book states that there is: models without targets have nothing to be similar to (p. 23). But the converse is also true. Models for which there is nothing for them to resemble are ones that are targetless, and so do not scientifically represent targets that they do not have. Pressing resemblance theorists on how such models do represent is an ignoratio elenchi.

Resemblance is said to be a "non-starter" and an even "more damning" failure when it comes to the misrepresentation condition (p. 23). This critique is also worth exploring further; for there is nothing about being a resemblance theorist that requires claiming that every model-based scientific representation is an accurate one. So what, exactly, is the problem? The authors' thought is that this conception cannot account for how m misrepresents t in virtue of the materially relevant or structural features that purportedly constitute the representation of t. But the suppressed premise seems to be that resemblance theorists are committed to claiming that scientific misrepresentation holds in virtue of resemblance relations. Possibly, here lies a red herring. Or even if not, their conception could instead treat a model's misrepresentation as a distribution problem: if scientific representation obtains in virtue of resemblance, perhaps m inaccurately represents t when the number of relevant resemblances are too few to meet a threshold for sufficient accuracy. Alternatively, perhaps the relevant resemblances are sufficiently numerous but deficient in their propinquity. Ultimately, the authors' objections, here, are worth taking very seriously; but it is hard to ascertain that resemblance theorists suffer a grave problem without a fuller-length treatment. This is especially the case since invoking resemblance is said to satisfy the gradation and contextuality conditions of the accuracy question (p. 26), and since the resemblance conception has answers to the third metaphysical 'model' question.

The book's third chapter offers a mild critique of the inferential conception of model-based representation, according to which m represents t iff agents can reason about t from m by making inferences. This conception overemphasizes the importance of the surrogative reasoning condition. And the condition itself is already an odd taxonomical fit in the obstacle course from chapter one given the product/process (models/modeling, etc.) distinction; for the form of an answer should match the form of the question asked, and questions about what something must have or be to count as a scientific representation are questions about its nature rather than about agents' exploitative powers and logical habits of mind. The book suggests that inferentialism satisfies many of the success conditions to the three questions; but the conception is let off the hook too easily. For example, directionality is said to be satisfied because m has a "representational force that points to" t (p. 38). But the concept of representational force is not given content, and what content there is to recover swings free of inferentialism; resemblance and DEKI theorists, for instance, could happily take up this commitment. Moreover, the 'pointing to' relation is also said to help inferentialism satisfy the directionality condition; but the overt circularity in claiming that asymmetric directionality is achieved through asymmetric pointing is ignored.

Finally, the book's fourth chapter explicates and defends the authors' own preferred conception, according to which a scientific representation consists in a fourfold complex of relations: denotation, exemplification, keying-up, and imputation. Specifically, a model m is defined as an ordered pair consisting of an object x and an interpretation, which is a mathematical injection from 'a set of features pertaining to x' to a set of features pertaining to its domain. Model m represents t just when it denotes t; exemplifies the set of features of the domain; has a key; and imputes a keyed feature to t. The chapter applies this conception to the concrete scale model of ocean liner propulsion, and Fig. 6 (p. 63) provides a neat visual summary.

The DEKI conception is rich and deserves much more exploration than can be given here. But one concern is whether it satisfies the targetlessness condition. The authors acknowledge that "if one were to include denotation as a necessary condition for scientific representation, then one would rule out models that don't represent any actual target. As such, one would violate the targetless models condition" (p. 38) because "targetless models don't denote" (p. 54). So, denotation is not just insufficient; it must also be unnecessary if DEKI is to satisfy the condition. To solve the problem, the authors recall a distinction between models that do denote ('representations of Z') versus those that do not denote ('Z-representations'). So, the DEKI definition renders models into Z-representations, which may be targetless, unless they do denote, in which case they are representations of Z. But how does that help? We can say that denotation is unnecessary for m to Z-represent but necessary for m's representation of Z. Yet, given the distinction, the conception could just dispense with the 'D' so long as EKI-theorists are willing to part with their stronger claim that denotation is "the core of representation" (p. 56); after all, occasionally it is not. Keeping it as an integral component maintains the tension. Another intriguing issue concerns keys. What are they? The book does detail what they are for, but suggests that there can be no general metaphysical answer about what they are. The authors do provide some suggestions in the case of mechanical models, however. There are some subtle uses of italicization that make for confusing notation. But overall, this is an extremely lucid and well-written *Element*, and anyone interested in the philosophy of models and modeling would do well to pick up a copy.

References

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