Synthese (2021) 198 (Suppl 21):S5009–S5013
https://doi.org/10.1007/s11229-021-03290-6

S.I.: MODELING AND REPRESENTATION

From structure preserving representation to making worlds with symbols

Introduction to the S.I.: Modeling and Representation: How to make worlds with symbols

Iñaki San Pedro[1]

Published online: 1 July 2021

This special issue aims to contribute to the current debate on scientific representation by exploring some departures from the mainstream view on the subject. We take that mainstream view to be a range of positions very close to representationalism, broadly understood, all of which have to some extent what is known as the 'model-target dyad' as a central assumption. In particular, concerning scientific representation, under such mainstream views it is commonplace to take represented images to be determined by reference to imposed conditions or features of a world taken as external and pre-existing with respect to the representational function itself.

In fact, today's most common views on scientific representation take it to be, under a strong demarcationist view of science, a specific and genuine type of representation in which the preservation of some particular structure linking model and target is the central concept. Such preservation of structure in turn provides scientific representations with an objective informative value, in contrast with other kind of representations. In this view thus most ontological and/or epistemological issues around representations are laid out in terms of the question as to what it is for a scientific object (e.g. a theory, model, etc.) to represent a particular phenomenon. Answers to this question most often involve the analysis of diverse problems concerning validation or verification of representations.

An increasing amount of new work in the area during the last three or four decades has lead to a substantial reshaping of our standard understanding of scientific representation. In particular, the understanding of (i) what is it what we represent, and (ii) how we actually represent it, has been subject to modification. Such new results build on a generalisation into extended scientific domains or practices where representations are performed—e.g. image production in nanoscience/technology, computer simulations, etc.—on the one hand, and on a departure from the traditional views on

✉ Iñaki San Pedro
isanpedro@ucm.es

[1] Department of Logic and Theoretical Philosophy, Complutense University of Madrid, Madrid, Spain

representation on the other—e.g. emphasising the role of models in representations instead of theories, or focusing on the actual scientific representation practices. More generally, these new views point to a wider richer notion of representation, which is to be better comprehended in a practice-based framework, strongly dependent on the specific local contexts where actual representations are produced.

This special issue was originally conceived with the goal to explore such new and alternative approaches to scientific representation from a different perspective, namely approaches of a strong pragmatic character, and those in particular that take representation as performative function. Such views have its roots in the works of philosophers such as Cassirer, Carnap or Goodman in the first half of the 20th Century, who provided a fresh look into the question as to how scientific representation is to be understood (Cassirer 1910, 1936; Carnap 1928; Goodman 1978). Nelson Goodman's proposal, for instance, conceived "world representations" as monadic single predicates, i.e. "representation-world", instead of the standard predicates involving two distinct relata—i.e. the 'model-target dyad', the represented object on the one hand and the description within the representation itself on the other—, which are central in the mainstream view of scientific representation. Thus Goodman's monadic predicates do not involve two distinct entities linked by denotation but a single one, i.e. the representation itself, which in turn refers to further representations. In this view then the most salient and relevant aspect to be analysed is what Goodman calls the "ways of world(s) making" by means of representations, which are now to be understood as symbols.

Consistently with the above the topics this special issue proposed to discuss revolved around questions such as: What kind of devices we make worlds through? What is the role of models in these? What is the role of instruments in such world-making procedures? Can such a constitution of worlds be said to be embodied in any sense? Are such world-making practices fundamentally different from other performative representational practices, e.g. art production practices? What are the validation and verification mechanisms for scientific world-making? How can we refer to a world (i.e. our actual world) in the pluralistic—both methodologically as well as ontologically—view suggested by performative representational practices? How should objectivity be semantically framed in such kind of world construction?

All eight papers that have been finally selected for this special issue address one or more of the questions above, either engaging with them directly, or indirectly by drawing on specific scientific practices or case examples.

The special issue opens with two papers by Paul Teller and Thomas Mormann respectively which set the general tone for the publication rather suitably by shedding new light on pre-logical positivist positions concerning scientific representation, and their influence on later developments in the field.

Thus, Teller's paper goes back to Carnap's idea of 'frameworks' to interpret Nelson Goodman's expression of "making worlds with symbols". Teller points out that Carnap's 'frameworks' provide a shift from a material mode, of existing properties, for instance, to a formal mode of a much more pragmatic character. The focus is shifted accordingly to the symbolic content of the language involved in 'property-talk'. As a result, 'frameworks' can be seen as symbolic systems which are not evaluated in terms of 'true-false', or 'correct-incorrect', but only in connection to their usefulness. Teller

argues further that Carnap's 'frameworks' constitute our main tool for accessing the world, and it is in this context that an expression such as Goodman's "world making" (out of symbols) is to be understood.

The notion of symbolic system, as well as its pragmatic dimension, plays also a central role in Cassirer's views on scientific representation. Indeed, Cassirer offered a new take on the concept of scientific representation based on the idea of structure-preserving symbolic systems continuously that evolve according to fundamentally pragmatic reasons. Such are the topics discussed in Thomas Mormann's contribution. Mormann argues, in particular, that accounts of scientific representation based on structure preservation in the vein of Cassirer's (but also Hertz'a and Helmholtz's) highlight some important aspects of the notion that current mainstream debates on the topic tend to neglect. In particular, taking on Reichenbach's suggestion that the Kantian a priori can be reformulated in terms of such structure-preserving representations, Mormann argues that accounts of representation based on structure-preserving maps or functions are linked to a priori aspects of scientific knowledge.

Changing the subject, Jay Odenbaugh's paper offers a critique of what still is an influential approach within the mainstream views on scientific representation, namely the similarity view. Odenbaugh's paper, in particular, addresses the particular difficulties faced by the similarity view raised by R. I. G. Hughes in connection with the fact that symbolic or mathematical objects such as those used in modelling cannot be said to have actual spatiotemporal properties, a basic requirement to establish a similarity correspondence with their represented counterparts. Odenbaugh sees in deflationary approaches of scientific representation the best avenue to deal with such problems, and puts forward his own deflationary proposal to this end.

Still from a perspective fundamentally critical with the mainstream views on the topic Tarja Knuuttila's contribution tackles the issue from the more concrete perspective of modelling as representational practice. Knuuttila's paper advances an artifactual view on models which aims as well to account for fictional features in these, while avoiding the problems standard imaginary views face. In particular, Knuuttila's artifactual approach stresses the role of strongly pragmatic aspects of external representational tools that take part in the generation of scientific knowledge. In doing that, Knuuttila's approach avoids the problems that imaginary views confront concerning the relation between imagined entities within models and actual representational tools, through which we acquire knowledge about real-world phenomena.

The second part of the special issue consists of four papers that focus specifically on concrete scientific practices and particular case studies that highlight important challenges to the mainstream views of scientific representation.

Eric Winsberg's contribution addresses issues concerning how the diversity in evidence has an impact on modelling, and in particular how reliable or informative models can be. In a representational context the issue points directly to the correspondence between representing and represented epistemic objects. Winsberg's paper focuses in the specific case of climate science and climate modelling, where models are built piecemeal, usually from a large number of sources of information. The main question here is whether, or why, does a diversity of evidence provide stronger support for climate models. The answer to such a question is to be found, according to Winsberg, in an explanatory notion of robustness.

The case of the missing satellites discussed by Katia Wilson is, on the other hand, a fine example of how the combination of specific observational data and computer models and simulations can be used to make reliable inferences about the existence of certain (perhaps hidden, or unknown) phenomena. Wilson shows, in particular, how computer models give rise to what we can call virtual worlds, which are however 'sufficiently realistic' for the scientists purposes. Combining such simulated data with observations scientist are able to 'construct' new sometimes unobserved epistemic objects, such as missing satellites. In fact, in the case of the missing satellites this performative feature of modelling is crucial to explain the apparent disagreement between simulated and observed data.

Vadim Keyser's contribution, on the other hand, explicitly addresses the performative character of experimental practices. In particular, Keyser introduces a distinction between *taking* and *making* measurements as two different experimental practices. The later is the crucial idea behind so called 'intervention-based experimental production' (IEP), where interventions are performed in order to produce new experimental objects or processes, i.e. 'effects'. IEP related practice thus clearly involves a strong performative character. But not only that, IEP can also be informative from a causal point of view in scientific representations, according to Keyser.

The special issue closes with a joint paper by Sanjay Chandrasekharan and Nancy Nersessian that follows the lead of the two previous contributions. Chandrasekharan and Nersessian, in particular, show how scientific practices in the bioengineering sciences that make extensive use of computational models display a strong performative character. As it is also common in other scientific disciplines, such computational models and simulations are built in a piecemeal fashion, bringing together many sources of information, data, theoretical components, etc. A distinctive feature of the bioengineering sciences, however, is related to the fact that computer models and simulations are used jointly with physical models to create prototypes of natural phenomena. This often results in the discovery of new concepts and structures. Chandrasekharan and Nersessian raise a number of questions regarding this kind of practice. It is of particular interest from the point of view of this special issue their discussion around a question very much linked to the performative 'power' of practice itself, namely how does the discovering of new concepts occur in models which are built using external representations involving significantly arbitrary components—this is what the authors refer to as 'the discovery problem'.

As stressed above, this special issue aimed to put light on some of the most important and currently discussed issues around scientific representation from an alternative perspective, which we have characterised through the "world making with symbols" motto inspired in Nelson Goodman's philosophy. This in turn urges for a shift of focus with respect to the current mainstream approach to these problems towards more pragmatic and practice-aware views.

We believe the sample of works above, given their variety and how they express, each in its way, a departure from the most commonplace views on scientific representation, indeed achieves the proposed original aim of the special issue. As such, by advancing these new approaches and analysis on the topic, and bringing them to the forefront of the debate to gain the visibility they deserve, this special issue is expected

to constitute a valuable contribution to the current discussion in the field of scientific representation.

Acknowledgements I would like to give my most sincere thanks in the first place to Andoni Ibarra for all his help and support throughout, both in the personal as well as professionally. Prof. Ibarra committed very generously to the tasks involved in the guest-editing of this special issue through most of the process. I shall thank as well all the authors that have taken part in the issue, for their confidence in the project, their patience throughout and of course their hard work to make it possible. Finally, I would like to thank the editorial team at Synthese for making this publication possible. I thank in particular Otávio Bueno for his support, understanding and patience throughout. Financial support is acknowledged from the Spanish Ministry of Science and Innovation (MICINN), Project Number FFI2014-60403-JIN, as well as form the Regional Basque Government's Department of Education and Linguistic Policy, Project Number IT644-13.

References

Carnap, R. (1928). *Der logische Aufbau der Welt.* Weltkreis Verlag, Berlin. Second edition, Meiner, Hamburg. Translated as The Logical Structure of the World, Rolf A. George (trans.), University of California Press, Berkeley, CA, 1967 (Aufbau).

Cassirer, E. (1910). *Substanzbegriff und Funktionsbegriff: Untersuchungen über die Grundfragen der Erkenntniskritik.* Bruno Cassirer, Berlin. Translated as *Substance and Function*. Chicago: Open Court, 1923.

Cassirer, E. (1936). *Determinismus und Indeterminismus in der modernen Physik.* Göteborgs Högskolas Årsskrift 42, Göteborg. Translated as *Determinism and Indeterminism in Modern Physics*. New Haven: Yale University Press, 1956.

Goodman, N. (1978). *Ways of worldmaking*. Indianapolis: Hacket.