Lecture "Structure and Semantics of Scientific Theories": da Costa and French, *Science and Partial Truth* (chs. 1–4)

Erik Curiel[†]

January 26, 2017

Contents

All quotes from da Costa and French (2005) unless otherwise noted.

1 Introduction: Aims and Overview

1. "a conceptually unitary and broadly rationalist account can be constructed which pays close attention to and incorporates two fundamental aspects of epistemic practice in general" (p. 3)

    a. "representations are, crucially, conceptually incomplete and open-ended, and the overall attitude adopted is a fallibilistic one. Doxastically, the representations employed in scientific practice are regarded, not as true in the correspondence sense, but as partially

[†]**Author's address**: Munich Center for Mathematical Philosophy, Ludwig-Maximilians-Universität, Ludwigstraße 31, 80539 München, Deutschland; Black Hole Initiative, Harvard University, 20 Garden Street, Cambridge, MA 02138; **email**: erik@strangebeautiful.com

true or approximately true" (pp. 3–4) — developed formally in analytic framework; "the notion of 'partial structures' into the model-theoretic or 'semantic' approach, the formalism of 'quasi' truth offers a way of accommodating the conceptual incompleteness inherent in scientific representations" (p. 4)—shades of Carnap's "partial interpretation"!

   b. "second aspect of practice concerns methodology rather than representation and truth. . . . [C]lassic discovery-justification distinction crumbles through doxastic parity. Our unitary epistemology then drives a unitary account of theory development" (p. 4)—we won't cover this

2. generalization of Tarski: Tarski captured "intentions" of correspondence theory of truth (they claim); they attempt to represent those of pragmatists, for representations that aren't perfect copies of worlds (incomplete, partial), agreement characterized by pragmatic notion of empirical consequences; their "partial model" does same as Tarski's model, characterizing "partial truth", and explicating concept of "model" or "structure" as used in scientific representation

3. fundamentally, still a "semantic" view of theories: a theory is represented by a family of partial structures (partial models), *non-linguistic*, not sentences, but what satisfies sentences (p. 5, italics theirs): "shift to a broadly *representational* and nonpropositional account of the objects of belief"

2 Ch. 1, "Truth, the Whole Truth, and Partial Truth"

2.1 Tarski

> "in order to talk rigorously of truth in this manner, we require not only a language L but also an interpretation $\mathcal{I}$ of L in a structure $\mathcal{A}$. This is what the metalanguage provides. A sentence of L is then true or false only with reference to $\mathcal{I}$; that is, truth and falsity are properties of sentences of a particular language L, in accordance with an interpretation $\mathcal{I}$ of L in some structure $\mathcal{A}$." [p. 10]

Three caveats:

1. "fragmentary" definition for non-formal languages

2. can't underpin realist conception of theories, since that needs approximate truth

3. there are other accounts of truth, *e.g.*, the pragmatic one

But, on the plus side, one may well think that the language of science, in so far as one considers it a part of ordinary language, consists of a part of it that *is* amenable to a Tarskian analysis (meaning, among other things, that the language of science is not rich enough to have names for sentences in the language, so that the standard semantic paradoxes can be avoided).

2.2 Pragmatic Truth

1. based on Mikenberg, da Costa, and Chuaqui (1986)
2. motivated by observation that general "representations" in scientific theories are more complex than the exemplary simple sentences/propositions Tarski's theory manifestly handles ("snow is white"), *e.g.*, conditionals of various forms (subjunctive), and other forms of modal statements
3. based on Peirce: "consider what effects, that might conceivably have practical bearings, we conceive the object of our conception to have. Then, our conception of these effects is the whole of our conception of the object" (*Collected Papers of Charles Sanders Peirce*, Vols. 1–6. Harvard University Press, p. 5.402)
4. focus on "conception of object" *not* on propositions about objects (p. 12, italics theirs): "The notion of the *conception* of an object expresses an epistemic totality that goes beyond that expressed by a proposition alone."—note change in *meaning* of truth, for they now talk of the truth of our *conceptions*, not (just) of the truth of propositions
    a. for them: "effects" is still to be characterized by truth as correspondence (to maintain "connection with reality, suitably construed", p. 13)
    b. "conception" is not just set of propositions: "It is only in the [Peircean ideally convergent] limit that our conception of an object can be regarded as the sum of some set of propositions, each of which is true in the correspondence sense" (p. 13).
5. *partial* conception is at any time prior to ideally convergent limit: open, completable in a variety of ways (as constrained by what is real)
6. So, pragmatism's "intentions" with regard to its conception (!) of truth, to capture (p. 15):
    a. The nature of agreement between, on the one hand, "imperfect" or "abstract" descriptions (idealizations, approximations) reflecting imperfect of partial knowledge and, on the other, reality
    b. The empirical consequences of such descriptions, understood as "agreeing" with reality in the classical correspondence sense; note inevitably and thoroughly modal character of this conception, since not all empirical consequences are or will be realized
    c. "Complete" or "absolute" truth, again understood in the classical correspondence sense, as the (ideal) terminus of all inquiry

So, in the end, the motivation for their account of the structure of theories and their semantics is driven by epistemic concerns (shades of Carnap), but they will then use the account to argue for ontological and metaphysical claims.

2.3 Truth and Partial Structures

1. still rely on semantic notions of "interpretation" and "structure":
    a. Δ, a domain of knowledge

   b. $\mathcal{D}$, a data-set representing certain "aspects" of Δ

   c. $\mathcal{A}$, a structure that "substitutes" for Δ "in our thoughts"—an "interpretation" of the language in which $\mathcal{D}$ is formulated

   d. S a sentence "about" Δ, by way of referring to $\mathcal{D}$, based on the "mapping" of $\mathcal{D}$ to Δ given by $\mathcal{A}$

2. now interpretations do not exhaustively map the domain, but are rather "partial"; so a *simple pragmatic structure* $\mathcal{A} =_{\text{df}} (\langle A, R_k\rangle_{k\in K}, \mathtt{L}, P)$, where

   a. A is a non-empty set

   b. K is an indexing set

   c. for each $k \in K$, R_k is a partial relation defined on A

   d. $\mathtt{L}$ is a language of the same similarity type as $\langle A, R_k\rangle_{k\in K}$, interpreted in it

   e. P is a set of sentences in $\mathtt{L}$

   R_k (of arity n_k) is "partial" in so far as it may not be defined for every n_k-tuple of elements of A—*N.b.*, this means that for a given n_k-tuple, either it is in R_k, it is not in it, or it is not defined whether or not is in it, *i.e.*, the domain of R_k may not be the entire set of n_k-tuples. Thus R_k is not a "relation" in the standard sense of Bourbaki (or Tarski), since "indeterminate whether it is part of the domain or not" cannot be captured by defining a domain! Technically, R_k should be defined as an ordered pair of n_k-tuples, the first those that satisfy the relation, and the second those that don't satisfy it; then all those not in either of the elements of the ordered pair are indeterminate. Note that da Costa and French define $\mathcal{A}$ to be $\langle A, R_k, P\rangle_{k\in K}$, but I find it misleading not to explicitly include $\mathtt{L}$ in their definition; they must do so for the sake of clarity and explicitness, since they do include P, but a set of sentences does not determine a language—thus, their "structure" is not non-linguistic, at least in the sense of Suppes, if not even less so.

3. $\mathcal{B}$ is an $\mathcal{A}$-*normal structure* if it extends $\langle A, R_k\rangle_{k\in K}$ in the obvious ways so as to make it a complete structure, and there is an interpretation $\mathcal{I}$ of $\mathcal{B}$ that is a model of the sentences in P, in the standard Tarskian sense; note that they really should say that it extends A *in the context of* $\mathtt{L}$

4. $S \in P$ is *pragmatically (or quasi-)true* in $\mathcal{A}$ if there exists an $\mathcal{A}$-normal structure; $S \notin P$ is *pragmatically (or quasi-)true* in $\mathcal{A}$ if there exists an $\mathcal{A}$-normal structure that is a Tarskian model of S, otherwise S is *pragmatically (or quasi-)false* in $\mathcal{A}$; *n.b.*, even if a sentence is pragmatically true, there may (and almost certainly will) exist $\mathcal{A}$-normal structures in which the sentence is false

5. It is crucial to their epistemic aims that a partial relation R_k does not "interpret" every n_k-tuple—some n_k-tuples we know for sure satisfy R_k, some we know for sure don't, and some we don't know either way, for our knowledge about the domain is incomplete in a strong sense.

6. Thus, a sentence S that is only pragmatically true cannot designate a proposition in the standard sense of that idea—we are forced to focus on the partial models, not on standard propositions!

7. Deeper shades of Carnap's conception of a partial interpretation! For if there is one $\mathcal{A}$-normal structure, then there will be, by Winnie's theorems, an infinite number of them.

8. But there are important differences with Carnap: interpretations for Carnap are partial because of the weaker epistemic accessibility we have to theoretical entities; interpretations are partial for da Costa and French because of the incomplete knowledge as a whole we have of the domain Δ.

9. It is also important to note, although they skate over this fact, that their account is *not* Peircean, in so far as there will be in general an infinite number of ideally convergent limits, and there is no reason to suspect all of them will be isomorphic in a significantly relevant sense—so how can this support structural realism?

3 Ch. 2, "Theories and Models"

3.1 Model Theory and the Philosophy of Science

1. "It is this 'essential' use of structures and their treatment as unitary individuals that we regard as fundamental; indeed, this view may be taken as the formal counterpart of the epistemic shift from the language in which our beliefs are expressed to the structural objects of those beliefs" (p. 22)—account of structure of theories tracks epistemology

2. "theories can be characterized by what their linguistic formulations refer to" (p. 22); 'characterized' is a weasel word—they do not actually define what a theory is, what does and does not belong to it; are the practical principles (perhaps correpsondence rules?) by which we determine what "the empirical consequences of a sentence actually are", *e.g.*, part of the theory? They do say (p. 22), the best we can do if we want to say what a theory is is to give an ostensive report by looking at practice, but that is a cop-out, since practice is infamously ambiguous, imprecise and even self-contradictory in this regard.

3.2 Theories as Partial Structures

1. model domain Δ by $\mathcal{A} = \langle A_1, R_i\rangle_{i\in I}$, for R_i partial relations, and "where A_1 is the set of observable individuals of Δ" (p. 28)! (What the fuck? If one can define observable individuals, then surely one can define observable vocabulary—but I thought they wanted to avoid this? Perhaps not. Perhaps they follow van Fraassen here.) Then throw in the theoretical individuals and set of (partial) relations defined over the union.

2. Note the absence of the set of sentences P—we are defining here only a structure to *represent* the domain of knowledge, not yet a theory in the sense of a structure that allows us to express possible beliefs or knowledge about it, since we need linguistic forms (sentences) for that

3. theories so construed are akin to Carnapian frameworks: one cannot represent possible beliefs (express assertions) about such "philosophical" matters as realism, *e.g.*, structural realism; such things are "external statements", and so much less may the theory give one the tools to investigate their truth values

3.3 Partial Structures and Partial Truth

1. theories can't be just classes of models, because otherwise there is no account of their partial truth (which is defined by the interpretation endowed on sentences by a normal structure extending a simple pragmatic structure—but a simple pragmatic structure, and *a fortiori* a structure that extends it normally, does not give an interpretation of a simple pragmatic structure!)

2. So the truth or pragmatic truth of a theory reduces to the truth of a set of sentences determining the simple pragmatic structure. (Note that they say, "The truth or pragmatic truth of the theory, in this case, is reduced to the truth or pragmatic truth of the set of sentences that determine the theory" (p. 30), but this makes no sense, since they have not yet said what a theory is.)

3. We may not be dealing with propositions in the traditional sense, but we must at least deal with sentences, unavoidably so, if we are to give an account of truth: "Hence, if we are to maintain the model-theoretic account of logical structure, we must retain the view that theories are the objects for doxastic attitudes, as expressed *linguistically* in statements and assertions" (p. 32). To *present* a theory must be done linguistically.

4. hence, Suppes' "extrinsic" versus "intrinsic" distinction: no matter what theories themselves *are* ontologically, extrinsically they are represented by classes of models, and intrinsically they are the objects of doxastic attitudes

5. to reconcile the model-theoretic with the syntactic, one notes the dual role of models: representation of theory *and* that in virtue of which sentences are true

6. This all assumes: "When describing a particular domain Δ, one assumes that it is possible to present such a description based on the properties of the elements of Δ, on the relations holding between them, on the functions that can be defined on Δ, and so on, and that somehow such a description correctly reflects certain aspects of this domain" (p. 34).

7. models, therefore, play the epistemic role of possible realizations satisfying sentences expressing beliefs; note that this raises a problem for realism: if I want to be a realist about "what a theory represents", in the sense that I take my beliefs about that to be (partially) true, but the satisfiers of my beliefs are the partial models, which are *formal* structures, then how can I be a realist about the stuff the models purport to be about? The most I seem to have epistemic access to are the partial models themselves, since those are what (to abuse language) "make my beliefs (partially) true (as the case may be)".

4 Ch. 3, "Models and Models"

This is a rich chapter, but time constraints do not allow us to cover it in lecture. If you're interested, one good question to ask yourself while reading and thinking it about is whether their discussion allows them to address the possible worry I raised above, in the last item of §3.3: if I want to be a realist about "what a theory represents", in the sense that I take my beliefs about that to be (partially) true, but the satisfiers of my beliefs are the partial models, which are *formal* structures, then how can I be a realist about the stuff the models purport to be about? The most I seem to have epistemic access to are the partial models themselves, since those are what (to abuse language) "make my beliefs (partially) true (as the case may be)".

5 Ch. 4, "Acceptance, Belief, and Commitment"

5.1 Representational Belief

1. "a 'representational' belief that p is ... understood as a belief that p is partially true only, whereas a factual belief that p is a belief that p is true in the correspondence sense" (p. 5); thus, awareness not of p *simpliciter* in doxastic state, but of commitment to particular representation of p, as invoked in standard accounts of "acceptance" rather than full belief, thus unified account of acceptance and belief

References

da Costa, N. and S. French (2005). *Science and Partial Truth: A Unitary Approach to Models and Scientific Reasoning*. Oxford: Oxford University Press.

Mikenberg, I., N. da Costa, and R. Chuaqui (1986). Pragmatic truth and approximation to truth. *Journal of Symbolic Logic 51*, 201–221. doi:10.2307/2273956.