Modeling Truth for Semantics*

Ori Simchen

Abstract

The Tarskian notion of truth-in-a-model is the paradigm formal capture of our pre-theoretical notion of truth for semantic purposes. But what exactly makes Tarski's construction so well suited for semantics is seldom discussed. In my *Semantics, Metasemantics, Aboutness* (OUP 2017) I articulate a certain requirement on the successful formal modeling of truth for semantics – "locality-per-reference" – against a background discussion of metasemantics and its relation to truth-conditional semantics. It is a requirement on any formal capture of sentential truth vis-à-vis the interpretation of singular terms and it is clearly met by the Tarskian notion. In this paper another such requirement is articulated – "locality-per-application" – which is an additional requirement on the formal capture of sentential truth, this time vis-à-vis the interpretation of predicates. This second requirement is also clearly met by the Tarskian notion. The two requirements taken together offer a fuller answer than has been hitherto available to the question what makes Tarski's notion of truth-in-a-model especially well suited for semantics.

How should truth be modeled for the purposes of truth-conditional semantics? The received paradigm is Tarski's work. Given the work's prominence and centrality for subsequent semantic theorizing, it is easy to forget that what Tarski did was offer a certain theoretical capture of an everyday notion, the notion of sentential truth. Holding the theoretical capture apart from the everyday notion allows us to reflect on the achievement by asking what makes a theoretical representation of truth especially well suited for semantics. The general question of how sentential truth should be modeled for semantic purposes is neither trivial nor uninteresting and yet seldom discussed in its own right. A preliminary exploration of an answer has appeared in Simchen (2017) against a background discussion of metasemantics and its relation

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to formal semantics. The purpose of this discussion is to make further progress on the issue.

The first order of business is to explain the context in which the question of how truth should be modeled arises in previous work on the topic, particularly in metasemantics. Think of metasemantics as the study of what determines that expressions have their semantic significance. There is a fault line in metasemantics between positions that portray endowment with semantic significance as determined directly by conditions surrounding the production or employment of the items thus endowed, and positions that portray semantic endowment as determined directly by conditions surrounding the interpretive consumption of such items. Examples of metasemantic views of the former sort are Donnellan's views on how certain uses of descriptions refer (by having a putative referent "in mind"), Kripke's views on how proper names refer (by initial acts of naming and subsequent causal-historical chains of communication), Kaplan's views on how demonstrative pronouns refer (by directing intentions), and Putnam's views on how kind terms come to apply to instances of the relevant kinds (by intending the term to apply to anything relevantly similar to paradigm instances of the kind). Examples of metasemantic views of the latter sort are Davidson's interpretationist notion that expressions are assigned semantic values so as to generate the right ("interpretive") truth-conditions for sentences in context, and the Lewisian interpretationist doctrine of reference magnetism according to which expressions are assigned semantic values so as to maximize truth for the total theory in which they are embedded while respecting objective joints in nature. Views of the former sort prioritize semantic endowment for sub-sentential expressions over semantic endowment for whole sentences in the order of metasemantic explanation. Views of the latter sort prioritize semantic endowment for sentences over semantic endowment for sub-sentential expressions.

In Simchen (2017), I offer an argument against interpretationism in metasemantics that aims to show that any such position is vulnerable to radical indeterminacy in singular reference. Whether or not the argument succeeds in its broad metasemantic aims is beyond our present concern. What is of interest to us here is the argument's deployment of an alternative construal of sentential truth. The argument considers a simple first-order extensional language L that contains besides the usual logical vocabulary only constants and predicate letters of various arities. A model m is understood in the usual way as a pairing of a domain (a universe of discourse) and an interpretation function that assigns to each constant a member of the domain and to each predicate letter of arity n a subset of the domain's n^{th} Cartesian power. As is familiar, the standard Tarskian construction of truth-in-a-model includes the following clause for the atomic cases:

$$m \models \phi(v_1, ..., v_i, t_1, ..., t_j)^s \iff \langle s(v_1), ..., s(v_i), \sigma(t_1), ..., \sigma(t_j)\rangle \in \sigma(\phi),$$

where s is an assignment function that assigns members of the domain to the free variables $v_1, ..., v_i$, $t_1, ..., t_j$ are constants, σ is the model's interpretation function, and ϕ is an n-place predicate letter ($n = i + j \geq 1$). The alternative construal of sentential truth – *scrambled-truth-in-a-model* ($\models^\rho$) – agrees with the standard Tarskian construal in all respects except for the atomic clause. For any $m = \langle M, \sigma\rangle$, a scrambler $\rho : M \longrightarrow M$ is a permutation on the domain M:

$$m \models^\rho \phi(v_1, ..., v_i, t_1, ..., t_j)^s \iff \langle \rho(s(v_1)), ..., \rho(s(v_i)), \rho(\sigma(t_1)), ..., \rho(\sigma(t_j))\rangle \in \sigma(\phi).$$

Scrambled-truth-in-a-model in effect generalizes the two-place Tarskian notion by adding a scrambler ρ as a third parameter, just as truth-in-a-model in effect generalizes monadic truth by adding a model m as a second parameter. Truth-in-a-model thus becomes a special case of scrambled-truth-in-a-model when ρ is identity, just as truth becomes a special case of truth-in-a-model when m is "intended".

Now, it is easily observed that for any model $m = \langle M, \sigma\rangle$, if $m^\mu = \langle M, \sigma^\mu\rangle$ is the same as m but for the fact that for any constant t of L, $\sigma^\mu(t) = \mu(\sigma(t))$ where μ is a permutation on M, then for any sentence S of L, $m \models S \iff m^\mu \models^{\mu^{-1}} S$. μ and μ^{-1} simply "cancel each other out".[1] This simple fact can be deployed to undermine a familiar Lewisian interpretationist attempt to disarm semantic indeterminacy arguments due to Putnam and others.

Here is some relevant background. In a number of writings from the late 1970s and early 1980s, Putnam has argued that a distinction held dear by metaphysical realists between epistemic ideality and realist truth collapses under minimal assumptions.[2] The metaphysical realist would like to maintain that epistemic ideality might, if we happen to be epistemically unlucky, fall short of realist truth. Putnam's argument, in a nutshell, is that an epistemically ideal theory would be at the very least consistent. So under minimal assumptions it would have a model of the same size as the world. And so, it would have a model with the world itself as its domain. Hence the theory in question is guaranteed to be true of the world itself. This is the notorious model-theoretic argument. Lewis's response to the argument was to say that not every interpretation of the theory's language into the world is on par with any other. Some interpretations are more eligible than others, given the way the world is. An interpretation is more eligible in Lewis's sense the more it respects objective joints

[1] Details can be found in Simchen (2017: 2.3).

[2] See, for example, Putnam (1977, 1978, 1981).

in nature. And there is no guarantee that the epistemically ideal theory would be rendered true by a reasonably eligible interpretation. Thus, according to Lewis, we can restore the idea that epistemic ideality is one thing and realist truth another. More broadly, what determines that expressions have the meanings they do is not just truth for the overall theory in which they partake, as assumed by Putnam's argument. That would leave language largely semantically indeterminate. What determines that expressions have the meanings they do is truth for the overall theory that respects the world's pre-existing structure. This is the Lewisian idea of reference magnetism.[3]

Unfortunately, the idea is ineffective in blocking semantic indeterminacy. Letting m^L be the Lewisian intended model $\langle M^L, \sigma^L \rangle$, where M^L is the intended domain, let us first assume that for any σ, $\sigma \neq \sigma^L$, σ is no more eligible in Lewis's sense than σ^L as an overall interpretation of the language when it comes to the predicates. σ^L is thus maximally eligible by Lewisian standards – the interpretations of predicate letters are maximally natural in Lewis's sense. Next, an alternative model $m' = \langle M^L, \sigma' \rangle$ is considered, where $\sigma'(\phi) = \sigma^L(\phi)$ for every ϕ so that maximal naturalness for the predicates is preserved. Letting $f : M^L \longrightarrow M^L$ be a nontrivial permutation such that for some constant t^*, $f(\sigma^L(t^*)) \neq \sigma^L(t^*)$, $\sigma'(t)$ is defined as $f(\sigma^L(t))$ for every consant t. It is then an immediate application of the general observation above that for any sentence S of L, $m^L \models S$ iff $m' \models^{f^{-1}} S$. The metasemantic upshot is that nothing the reference magnetist can offer here will decide which of m^L and m' is intended. σ^L and σ' are equally maximally eligible by Lewisian standards and can differ as radically as we like on the interpretation of L's singular terms. Semantic indeterminacy is thus fully restored.

Before moving on, we note that this kind of indeterminacy in singular reference is not a simple rehashing of standard semantic indeterminacy arguments. In this version the interpretation of predicate letters can remain fixed while the interpretation of the singular terms varies by utilizing the triadic scrambled-truth-in-a-model construction. That is why reference magnetism, despite its insistence on relative fixity in the interpretation of predicate letters, is incapable of blocking the argument without special pleading.

But now stepping back and considering scrambled-truth-in-a-model in its own right raises a question of independent interest: What advantage does Tarski's apparatus of truth-in-a-model enjoy over scrambled-truth-in-a-model as a formal capture

[3]See Lewis (1983, 1984) for the original articulation of the idea and some of its ramifications. No claim is being made here as to the metasemantic position articulated in Lewis (1975). However, the idea of tacking eligibility of interpretation in terms of naturalness onto the metasemantic account of Lewis (1975) is difficult to motivate. See Simchen (2017): Appendix I.

of sentential truth for semantic purposes? – For clearly we cannot take scrambled-truth-in-a-model seriously as an alternative to truth-in-a-model for the purposes of truth-conditional semantics. The qualification 'for the purposes of truth-conditional semantics' is important because even if we discern some significant abstract model theoretic difference between the two alternative captures of sentential truth, this by itself does not without argument entail a decisive advantage for one construction over the other for the purposes of semantic theory.[4] The answer offered in Simchen (2017) to the advantage question is that the original Tarskian construction respects a natural and intuitive locality-per-reference requirement on modeling sentential truth: truth for singular sentences must be directly dependent on reference for singular terms. Tarksian truth-in-a-model clearly abides by the requirement while scrambled-truth-in-a-model clearly flouts it – truth in the atomic cases on that alternative scheme depends on reference for singular terms only as mediated by a scrambler. This turns out to be important in the metasemantic context. Interpretationism as a metasemantic orientation makes semantic endowment for singular terms beholden to semantic endowment for whole sentences: truth and falsity come first in the order of metasemantic explanation while sub-sentential reference is derived. The requirement of locality-per-reference, on the other hand, allots priority to sub-sentential reference over sentential truth and falsity. It is thus the natural accompaniment to non-interpretationist metasemantic views that recognize reference as fixed prior to truth. It is of course open to a metasemantic interpretationist to insist on locality-per-reference as a constraint on modeling truth in order to block the new indeterminacy argument. But such insistence seems ad hoc in comparison with the non-interpretationist justification for the constraint. Non-interpretationist views seem at a clear advantage here, already having resources to account for the fact that scrambled-truth-in-a-model is not what we want from a formal capture of sentential truth. Theory choice in semantics, it appears, is not metasemantically neutral.

The focus of the indeterminacy argument in Simchen (2017) is metasemantics, the study of how it is that expressions become "loaded" with their contributions to truth-conditions. But the proposed requirement of locality-per-reference on modeling truth for semantics raises a concern of independent interest. Tarski's "straight" notion of truth-in-a-model, as compared with my "bent" notion of scrambled-truth-in-a-model, is so very clearly superior in modeling the everyday notion of sentential truth for semantic purposes. A pressing question is what accounts for this phenomenology. Regardless of what we are inclined to think about the prospects of metasemantics

[4]See Simchen (2017: 47). See also further discussion of this point as it pertains to the alternative construction discussed below.

as a field of inquiry, the comparison of Tarski's notion with neighboring notions seems important to the philosophy of the science of formal semantics. For given the prominence of Tarski's work for subsequent semantic theorizing, such a comparison enables us to achieve a better understanding of theoretical choices that lie at the core of the enterprise of truth-conditional semantics.

With this in mind, let us now ask: What other requirements might there be on modeling truth beyond locality-per-reference? My next aim is to articulate another such requirement. Let us consider another alternative theoretical capture of sentential truth – *jumbled-truth-in-a-model* ($\models_\tau$) – which again agrees with the standard Tarskian construal in all respects except for the atomic clause. For any $m = \langle M, \sigma \rangle$, a jumbler τ is a permutation on $\mathcal{P}(M^n)$ (the power set of M's n^{th} Cartesian power) for every n:

$$m \models_\tau \phi(v_1, ..., v_i, t_1, ..., t_j)^s \iff \langle s(v_1), ..., s(v_i), \sigma(t_1), ..., \sigma(t_j) \rangle \in \tau(\sigma(\phi)).$$

Truth-in-a-model becomes a special case of jumbled-truth-in-a-model when τ is identity.

Now, it is easily observed that for any model $m = \langle M, \sigma \rangle$, if $m_\pi = \langle M, \sigma_\pi \rangle$ is the same as m but for the fact that for any n and any predicate letter P^n of L, $\sigma_\pi(P^n) = \pi(\sigma(P^n))$ where π is a permutation on $\mathcal{P}(M^n)$, then for any sentence S of L, $m \models S \iff m_\pi \models_{\pi^{-1}} S$. We see this by focusing on atomic sentences $\phi(t_1, ..., t_n)$ – generalizing to atomic formulas is trivial and full generality follows by induction on syntactic complexity:

$$\begin{aligned}
&m_\pi \models_{\pi-1} \phi(t_1, ..., t_n) \iff \\
&\langle \sigma_\pi(t_1), ..., \sigma_\pi(t_n) \rangle \in \pi^{-1}(\sigma_\pi(\phi)) \iff \\
&\langle \sigma(t_1), ..., \sigma(t_n) \rangle \in \pi^{-1}(\pi(\sigma(\phi))) \iff \\
&\langle \sigma(t_1), ..., \sigma(t_n) \rangle \in \sigma(\phi) \iff \\
&m \models \phi(t_1, ..., t_n).
\end{aligned}$$

This construction can be deployed to undermine Lewisian reference magnetism even further by enabling indeterminacy in the application of predicates which is again immune to the magnetist proposal. Consider the Lewisian intended model $m^L = \langle M^L, \sigma^L \rangle$ with the maximally eligible σ^L. Let us define an interpretation σ'', $\sigma'' \neq \sigma^L$, that agrees with σ^L on the assignments to every constant but potentially disagrees on the assignments to the predicate letters. For each n for which L contains a predicate letter of that arity we consider a nontrivial permutation g_n on the set $\{\sigma^L(P_1^n), \sigma^L(P_2^n), \sigma^L(P_3^n), ...\}$ of assignments to all of L's predicate letters P_1^n, P_2^n,

P_3^n, ... (if no such nontrivial permutation exists we let g_n go trivial).[5] Now, for any arity n and any predicate letter ϕ of this arity we define $g(\sigma^L(\phi)) = g_n(\sigma^L(\phi))$ and define $\sigma''(\phi) = g(\sigma^L(\phi))$ for each ϕ and $\sigma''(t) = \sigma^L(t)$ for each constant t. From this definition of g, it is clear that there is a mapping $\mathcal{G} : \mathcal{P}(M^n) \longrightarrow \mathcal{P}(M^n)$ for every n that extends g. Clearly $\mathcal{G}^{-1}$ is a jumbler. Where $m'' = \langle M^L, \sigma'' \rangle$, it follows from the above that for any sentence S of L, $m^L \models S$ iff $m'' \models_{\mathcal{G}^{-1}} S$.

We note that m^L and m'' are equally maximally eligible by Lewisian standards. So under the minimal assumption that there be an n for which L contains more than a single predicate letter of that arity, the upshot is indeterminacy in the application of predicates sustained by the availability of an alternative construal of sentential truth. It is yet another form of semantic indeterminacy that passes under the radar of reference magnetism.

Jumbled-truth-in-a-model presents yet another challenge: What advantage does truth-in-a-model have over jumbled-truth-in-a-model as a formal capture of sentential truth? – For surely jumbled-truth-in-a-model cannot be taken seriously for semantic purposes despite the fact that unlike scrambled-truth-in-a-model, jumbled-truth-in-a-model does not violate the aforementioned locality-per-reference constraint. And yet jumbled-truth-in-a-model is as unsuitable for modeling sentential truth as the other construction.

Echoing an analogous point made in Simchen (2017), we note that an answer to this new advantage question cannot merely point to some abstract feature truth-in-a-model has and jumbled-truth-in-a-model lacks without further argument as to why having this feature should matter to semantics. For example, truth-in-a-model exhibits invariance under isomorphism:

$$\text{If } m \models S \text{ and } m \cong m^\bullet, \text{then } m^\bullet \models S. \tag{IUI}$$

But it is surely not the case that for any $m = \langle M, \sigma \rangle$, if $m \models_\tau S$ and $m \cong m^\bullet$, then $m^\bullet \models_\tau S$. For suppose that $m \models_\tau \phi(t_1, ..., t_n)$. Then for any $m^\bullet = \langle M^\bullet, \sigma^\bullet \rangle$ for which $M \cap M^\bullet = \varnothing$, $\tau(\sigma^\bullet(\phi))$ will be undefined, and so $m^\bullet \models_\tau \phi(t_1, ..., t_n)$ will be undefined. Indeed, jumbled-truth-in-a-model has the following feature instead:

$$\text{If } m \models_\tau S \text{ and } m \cong m^\bullet, \text{then } m^\bullet \models_{\tau^\bullet} S, \tag{IUI*}$$

where $\tau^\bullet = I^\bullet \circ \tau \circ I^{\bullet -1}$ and $I^\bullet$ is a mapping such that for each $s \subseteq M^n$, $I^\bullet(s) = \{\langle I(o_1), ..., I(o_n)\rangle \mid \langle o_1, ..., o_n \rangle \in s\}$ where $I : M \longrightarrow M^\bullet$ is the isomorphism.

[5] Clearly for any n for which L contains only a single predicate letter of that arity the requirement of nontriviality cannot be met.

We can see that jumbled-truth-in-a-model has IUI* by focusing again on atomic sentences – generalizing to atomic formulas is once again trivial and full generality follows by induction on syntactic complexity. Thus,

$$\begin{aligned}
&m \models_\tau \phi(t_1, ..., t_n) \iff \\
&\langle \sigma(t_1), ..., \sigma(t_n) \rangle \in \tau(\sigma(\phi)) \iff \\
&\langle I(\sigma(t_1)), ..., I(\sigma(t_n)) \in I^\bullet(\tau(\sigma(\phi))) \iff \\
&\langle \sigma^\bullet(t_1), ..., \sigma^\bullet(t_n) \rangle \in I^\bullet(\tau(\sigma(\phi))).
\end{aligned}$$

On the other hand, for each ϕ we have $\sigma^\bullet(\phi) = I^\bullet(\sigma(\phi))$, so that $I^{\bullet -1}(\sigma^\bullet(\phi)) = \sigma(\phi)$. Substituting in the last clause gets us:

$$\langle \sigma^\bullet(t_1), ..., \sigma^\bullet(t_n) \rangle \in I^\bullet(\tau(I^{\bullet -1}(\sigma^\bullet(\phi)))).$$

We see that $I^\bullet \circ \tau \circ I^{\bullet -1}$ is a jumbler on $M^\bullet$, from which we conclude that

$$m^\bullet \models_{\tau^\bullet} \phi(t_1, ..., t_n),$$

where $\tau^\bullet = I^\bullet \circ \tau \circ I^{\bullet -1}$.

But why exactly IUI should be important for semantic purposes – as opposed to IUI*, say – is a question that must be faced by anyone who wishes to tackle the contrast between truth-in-a-model and neighboring notions such as jumbled-truth-in-a-model "in the abstract", as it were. It is a difficult question. An answer would seem to require, at a bare minimum, an exploration of the scope of semantic theory in relation to the logicality of its fundamental notions.

However, there is a far more obvious and direct route to why jumbled-truth-in-a-model is unsuitable for semantic purposes: jumbled-truth-in-a-model fails to respect a natural and intuitive locality-per-application requirement on modeling sentential truth that truth-in-a-model clearly respects. Locality-per-application is the requirement that sentential truth for singular sentences should depend directly on the application of the predicates. In jumbled-truth-in-a-model this requirement is clearly flouted: for an atomic sentence to be jumbledly true in a model is not for the predicate to apply to the referents of the singular terms but for its jumbling to thus apply. This is obviously not so for Tarksi's original construction of truth-in-a-model, where truth for atomic cases depends directly on the application of the predicates.

As a side note, locality-per-application is a challenge to the metasemantic interpretationist just as much as locality-per-reference and for the same reason. The interpretationist orientation in metasemantics renders semantic endowment for sub-sentential expressions beholden to the semantic endowment for the sentences in which they partake. For non-interpretationist views, on the other hand, the situation is reversed. The non-interpretationist can and must insist not only on reference for singular terms as settled prior to truth but also on predicate applicability as settled prior to truth. Once again, non-interpretationism is at a clear advantage over interpretationism as a metasemantic orientation to accompany truth-conditional semantic theory. It is the natural metasemantic partner to the two requirements on modeling sentential truth we have been considering, locality-per-reference and locality-per-application.

On one level it is hardly surprising that scrambled-truth-in-a-model and jumbled-truth-in-a-model should be inferior to standard truth-in-a-model as theoretical representations of sentential truth. The requirements of locality-per-reference and locality-per-application are, after all, natural and intuitive. As such, they are to be respected by any theoretical articulation of our everyday notion of truth. Insofar as semantics concerns itself with the formal modeling of language-world relations – a widespread even if not universally shared conception – it is hardly surprising that truth-in-a-model should be found suitable for semantics, so suitable in fact that we tend to overlook the features that render it so. It is perhaps more surprising that semantics as it is widely understood is difficult to reconcile with interpretationism as a metasemantic orientation. Teasing out further lessons from this last observation, especially lessons for the history of formal semantics and the seminal contributions made to it by leading metasemantic interpretationists, is a larger project for another day. In the meantime we note that comparing the Tarskian notion of truth-in-a-model with neighboring notions affords us a better understanding than hitherto available of theoretical choices that lie at the basis of contemporary semantics.

Finally, the question how to represent theoretically the pretheoretical notion of truth for semantic purposes is not answered in the way we might initially be inclined to answer the parallel question in the metaphysics of truth.[6] The metaphysical question whether truth-in-a-model reveals what truth really is, at bottom, is beside the semantic point. We could represent truth by deploying the Tarskian construction of truth-in-a-model ($\models$) under the stipulation of an intended model. Or we could represent truth deploying the more general scrambled-truth-in-a-model construction ($\models^{\rho}$) under the stipulation of an intended model and the further stipulation that the scrambler go trivial. Or we could represent truth deploying the jumbled-truth-in-a-model construction ($\models_{\tau}$) under the stipulation of an intended model and the further

[6]Although even here, judging by the situation in neighboring metaphysical pursuits, how we might initially be inclined to answer such a question can easily come apart from how we should answer it upon reflection. See Simchen (forthcoming) for a related discussion of these matters in the metaphysics of what is said.

stipulation that the jumbler go trivial. Or we could represent truth deploying the most general construction of scrambled-and-jumbled-truth-in-a-model ($\models^{\rho}_{\tau}$) under all three stipulations (intended model, trivial scrambler, trivial jumbler). It could then be argued that the advantage of truth-in-a-model over the alternative constructions is obvious given the need for the extra stipulations to approximate answerability to the requirements of locality-per-reference and locality-per-application in the other cases. But the issue would not be settled by an emphatic insistence that truth-in-a-model is revelatory of the nature of truth while the alternative constructions are not, as is the wont of the metaphysician of truth.[7]

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