

## Foundational Ontologies and the Realist Bias

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### Descriptive Adequacy and the Realist Bias

According to received AI wisdom, an ontology is the formal statement of a model specifying a conceptualisation shared among communicating agents (Gruber 1991, 1995; Guarino 1998). However, it is not sufficient for an ontology to be merely consensual. The fact that ontologies, whether in the medical field or in the area of business operations, have to be updated and revised, reveals that the quality of an ontology hinges on its *descriptive adequacy*.

The requirement of descriptive adequacy is easily overlooked by knowledge engineers, as the task of specifying the content of ontologies is rightly attributed to the domain experts. But even though perfect knowledge is an unattainable goal, it is nevertheless true that inadequate ontologies are just *bad* ontologies.

Ontologies designed to describe a certain domain adequately, are called *reference ontologies* (Smith 2003), since they have a realist bias. Indeed, reference ontologies contain the implicit claim that they are true about a certain portion of reality and not just that they express a more or less broad consensus among a community of experts.

### Foundational Ontologies and the Semantics of Non-Logical Primitives

Foundational ontologies are *top-level* reference ontologies; though their starting point are the intuitions of common-sense as the conceptualisation of reality by humans (Strawson 1959), they ultimately aim at describing the categorial structure of the world as a whole. Foundational ontologies provide an axiomatic framework constraining the meaning of high-level information modelling predicates such as *parthood*, *dependence* or *spatio-temporal connection* (Gangemi et al. 2002).

Without doubt, the development of description logics as efficiently computable subsets of first-order logic has established a solid logical basis for knowledge representation. But even staunch defenders of description logics will agree that there is more to an ontology than mere formal logic and the computation of subsumption links in a taxonomy of monadic predicates. Already in the late seventies, Ron Brachman, who is still one of the main figures in the description logic community, has argued that many fundamental primitives of a knowledge representation formalism are actually non-logical (cf. Brachman 1979; his ideas are based on previous work of Woods (1975) and are akin to those in Newell 1982 and in Newell 1993). To make a comparison with mathematics: an axiomatic number theory contains axioms and inference rules not only for logical primitives, like connectors and quantifiers, but also for those operators that are specific to arithmetics, such as addition or multiplication.

The inference rules for the operators of a description logic are trivially irrelevant for the non-logical predicates in an ontology. In particular, we need formal theories that provide axioms and deduction rules for high-level non-logical primitives as those of mereology, topology and the theory of dependence. Thus, in addition to the reasoning services offered by the different description logics, we require those of foundational ontologies that are the top-level theories specifying the general categories and relations pervading reality.

## In Defense of Realism

Epistemological realism is the thesis that there is a world that exists independently of our perceptions, speech acts or conventions and that can be known to us. It is true that realism is a *belief*, an epistemological *bias* or *stance*. However, it is a *stance* based on cogent reasons.

First, as Moore (1959) has pointed out, realism is an ensconced credence of common-sense which we act upon in our every-day life, however sceptical we might be in seminars or salons. Now, a basic principle of scientific rationality is to stick to an established theory unless there is compelling evidence against it. Hence it is the antirealist party that has to bear the burden of proof. Second, single counter-examples of epistemic errors like sense-delusions are insufficient to motivate a general doubt about the existence of an external world. Third, failures only make sense on the basis of criteria for success, which themselves presuppose the background of an extended experience of effectiveness.

But there are not only pragmatic reasons to be a realist. Indeed, a simple thought experiment shows that antirealism is meaningless. Any antirealist stance presupposes the realist account as its context and starting point: when we doubt about the existence of the external world and hold that only our concepts and sense-data are given, then we already take the meaning of the phrases “external world”, “concept” and “sense-data” for granted. Now, realism is a theory about known objects, knowing subjects, as well as perceptions and cognitions; these terms are interrelated inasmuch none makes sense without all the other together. By rejecting one item of the theory, namely the external world, antirealism discards the whole of realistic discourse and hence undermines its very foundation. Thus we have also an indirect *a priori* argument for epistemological realism.

While the brute existence of an external world is beyond any doubt, it seems far less obvious that there should be a unique theory that truthfully describes this reality. Indeed, Quine has famously argued that the reference of natural language expressions is underdetermined by the empirical evidence available to the speakers and, as a result, translation is (mostly) indeterminate (Quine 1960, pp. 29-45; Quine 1969). If this were true, it would corroborate a pervading ontological relativism, and justify a pluralism of metaphysical theories or views, since there would be multiple mereological partitions of the world, many ways of thrawling through reality, that are orthogonal to each other.

However, Horwich (1998, pp. 199-200) rightly argues that even if there were a multiplicity of translations which would equally fit the empirical evidence about the foreign speaker’s linguistic behaviour, it could still be the case that there is a unique interpretation which is as a matter of fact the only correct one. One can just dismiss Quine’s argument by rejecting the pragmatist identification of the *empirically adequate* with the *factually correct*. Furthermore, so Horwich, the fact that a native speaker would assent to more than one translation in a certain situation does not mean that she would not give preference to one of them on the basis of the ordinary usage of her language (1998, p. 202\_). Above all, concluding from an empirical indeterminacy of interpretation to a metaphysical relativism just amounts to a confusion between epistemology and ontology.

Of course, the way how we partition reality is often not just based on (our knowledge of) its joints, but also on conventions. Since conventions are usually only partially defined and are liable to compete with each other, this means that many partitions are inherently vague (cf. Heller 1990, pp. 47–49). Now, since social constructionism is false with regard to the material world and with regard to much anything else except social objects, issues of vagueness should mainly appear in respect of truly conventional objects as those constituting social reality. If there is a possibility of an ontological pluralism of any sort, it should be in the domain of social ontology, but certainly not with respect to the basic ontology of substances and events. There is not enough to tell about the world to fill a whole library of foundational ontologies. All there is to be seen in the world can be seen from one window.

## Semantics and Realism

In a truth-functional account of semantics, the problem of determining the truth value of a sentence of arbitrary logical complexity reduces to that of fixing the truth-values of atomic sentences. The truth of an atomic sentence can be realistically stated as a correspondence between this assertion and some portion of the world. A recent attempt to account for this correspondence in terms of a truthmaking relation is to be found in Smith 1999 and Smith 2002. However, I believe that his approach fails to do justice to the requirements of scientific realism as it retains as the sole truthmakers the *urelemente* of the domain and ignores the role of formal relations.

Formal relations like parthood and dependence represent the backbone of a foundational ontology and their presence or absence in the *urelemente* really makes a difference in reality. Consider a human body and its heart: it is both the case that the heart is part of the body and that it is dependent on the latter. Smith's theory assigns the same truthmakers (the heart and the body) to both statements and thus cannot account for the semantic difference between the latter. Furthermore, in his approach, the true statement that the heart is part of the body and the false assertion that the body is part of its heart, have the same truthmakers.

With Mulligan (1998, p. 327), I contend that formal relations play a substantial role in truthmaking - lest foundational ontologies are devoid of any realistic basis. Actually, I agree with Hayes (1985, p. 10, fn. 4) that a realistically biased Tarskian semantics is all that is needed for the purpose of reference ontologies. As Davidson (1984, p. 48) has pointed out, Tarskian semantics can be regarded as a correspondence theory of truth, since it is based on an interpretation function that maps the names and predicates of a foundational ontology onto the *urelemente* and formal relations in reality.

According to Kripke (1980, pp. 91-97, 138-139) and Field (1972), this interpretation or naming relation can be seen as being rigidly determined by realworld causal links. These causal chains may involve steps of transmitting and adopting word usage from one agent to another, but are ultimately founded on direct causations of speech behaviour by environment stimuli. These basic triggerings bypass any representation; through them, the world acts as its own model (Brooks 1991).

Formal relations hold of their relata directly, without the nexus of exemplification being mediated by any relation-instance as a material link. The nexus between a formal relation and its relata is ontologically unanalysable and can only be described on the meta-theoretical level. Indeed, we say that an atomic statement derivable from an ontology is true iff the tuple consisting of the causal denotata of the constants is contained in the extension of the causal denotatum of the predicate. This account obviously requires some set theory (in fact just a modest fragment of the latter), but there is no need to see more in it than a part of the metalogical machinery. The set-theoretic constructs entering in the semantic account are fully determined by the real-world causal denotata, such that truthmaking completely relies on the sole denizens of the world. A Tarskian semantics that is thus grounded in the world amounts to a realistic, causal theory of truth (Field 1972).

## Conclusions

Foundational ontologies are indispensable for fixing the meaning of high-level predicates that represent formal relations pervading reality as a whole. They are reference ontologies and hence embody a realist stance. Indeed, descriptive adequacy is a basic requirement for any ontology and presupposes realism about the external world. Epistemological realism, so I have argued, is a rational theory based on cogent *a posteriori* and *a priori evidence*. A causal story about truthmaking can be told that solidly grounds (Tarskian) semantics on a robust common-sense realism that gives some leeway to ontological pluralism.

## References

- Brachman, R. J. 1979. "On the Epistemological Status of Semantic Networks". In Findler, N. V., (ed.), *Associative Networks: Representation and Use of Knowledge by Computers*, New York: Academic Press: pp. 3-50.
- Brooks, R.A., "Intelligence without representation". *Artificial Intelligence* 47, pp. 139-159.
- Davidson, D. 1984. "True to the Facts". In Davidson, D., *Inquiries into Truth and Interpretation*. Oxford: Clarendon Press, pp. 37-54.
- Field, H. 1972. "Tarski's Theory of Truth". *The Journal of Philosophy* 69/13, pp. 347-375.
- Gangemi A., Guarino N., Masolo C., Oltramari, A., Schneider L., 2002. "Sweetening Ontologies with DOLCE". In G'omez-P'erez, A., Benjamins, V.R., (eds.), *Knowledge Engineering and Knowledge Management. Ontologies and the Semantic Web. Proceedings of the 13th International Conference (EKAW 2002)*. Lecture Notes in Computer Science 2473. Heidelberg: Springer, 166-181.
- Guarino N. 1998. "Formal Ontology and Information Systems". In Guarino, N. (ed.), *Formal Ontology in Information Science. Proceedings of FOIS'98, Trento, Italy*. Amsterdam: IOS Press, pp. 3-15.
- Gruber, T. 1991. "The Role of Common Ontology in Achieving Sharable, Reusable Knowledge Bases". *Principles of Knowledge Representation and Reasoning: Proceedings of the Second International Conference*. Morgan Kaufmann, San Mateo/CA.
- Gruber, T. 1995. "Toward Principles for the Design of Ontologies Used for Knowledge Sharing". *International Journal of Human and Computer Studies. Special Issue: Formal Ontology, Conceptual Analysis and Knowledge Representation*.
- Hayes, P. J. 1985. "The Second Naive Physics Manifesto". In Hobbs, J.R., Moore, R.C. (eds.), *Formal Theories of the Commonsense World*, NJ: Ablex Publishing Group, pp. 1-36.
- Heller, M. 1990. *The Ontology of Physical Objects*. Cambridge: Cambridge University Press.
- Horwich, P. 1998. *Meaning*. Oxford: Clarendon.
- Kripke, S. 1980 (1972). *Naming and Necessity*. Oxford: Blackwell.
- Moore, G.E. 1959. "A Defense of Common Sense". In Moore, G.E., *Philosophical Papers*, London: Allen & Unwin, pp 32-59.
- Mulligan, K. 1998. "Relations – through thick and thin". *Erkenntnis* 48, pp. 325-353.
- Newell, A. 1982. "The knowledge level". *Artificial Intelligence* 18, pp. 87-127.
- Newell, A. 1993. "Reflections on the knowledge level". *Artificial Intelligence* 59, pp. 31-38.
- Quine, W. V. 1960. *Word and Object*. Cambridge/MA.: MIT Press.
- Quine, W. V. 1969. "Ontological Relativity". *The Journal of Philosophy* 65/7, pp. 185-212.
- Smith, B, 1999. "Truthmaker Realism". *Australasian Journal of Philosophy* 77/3, pp. 274-291.
- Smith, B, 2002. "Truthmaker Realism: Response to Gregory". *Australasian Journal of Philosophy* 80/2, pp. 231-234.
- Smith, B, 2003. "Ontology". Forthcoming in Floridi, L. (ed.), *The Blackwell Guide to the Philosophy of Information and Computing*. Oxford: Blackwell.
- Strawson, P. 1959. *Individuals. An Essay in Descriptive Methaphysics*. London: Routledge.
- Woods, W. A. 1975. "What's in a Link: Foundations for Semantic Networks". In Bobrow, D. G., Collins, A. M. (eds.), *Representation and Understanding: Studies in Cognitive Science*, New York: Academic Press, pp. 35-82.