Foundational Ontologies: From Theory to Practice and Back

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Abstract

This is a commentary on the article by Augusto (2022; this issue) on categories and foundation ontology (FO). We agree that the notion of categories of kinds of elements to devise a FO deserves more attention than it has received to date. From a practical point of view *sensu* developing domain ontologies, however, it probably does not matter much as long as a FO is used and that that one was understood.

Key words: Foundational ontologies; BFO; DOLCE; GFO; UFO; Ontology development tools

1 Introduction

In this same journal issue, Luis Augusto elaborates on foundational ontologies (FOs), what goes in the process to make them, and the multiple resultant categories and classifications that come rolling out of it as a result–or at least that that should be the case. He also argues that current FOs that are "in production" status–i.e., are being used, such as GFO (Herre, 2010) and UFO (Guizzardi et al., 2022)[1]–are falling short. This claim is intriguing for several reasons. First, since they are being used, they would not be so bad, would they? Or: is that "badness" only bad in theory or also in practice and their use has led to defective applications? Second, there is

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[1] Here and below in this paragraph, reference articles are given for the mentioned foundational ontologies.

one empirical evaluation on the effectiveness of FO/no-FO in domain ontology development (Keet, 2011) and one regarding FOs in conceptual data model development for database and software application design (Verdonck et al., 2019) and they both concluded that the quality of the resultant ontologies and models are better thanks to using a FO compared to not using one. Different FOs were used in those experiments (BFO [Arp et al., 2015], DOLCE [Masolo et al., 2003], and UFO). If those defects in FOs are non-negligible, then, to substantiate the claim of inadequate FOs, should they not have been either fixed or substituted with a better-designed FO, the experiments re-run, and determined that the quality of the ontologies and models is even better? Third, might it not be a bigger problem that many an artefact with a ".owl" file extension would benefit comparatively more from using at least one of the existing FOs rather than waiting for an even better FO? In this brief commentary, we cannot possibly answer all these questions, but shall touch upon the aspects of key elements and the notion of operationalising the use of FOs for "the masses," i.e., beyond scholarship in philosophy. As disclaimer, perhaps: we are looking at the matter from an Applied Ontology angle and are akin to "philosophy users" rather than philosophers by training.

2 On Considering Key Content of a FO

Augusto commences with stating two criteria against which to hold a FO: "It is largely agreed that the ontological categories ... (i) should be understood as the most general kinds of things and (ii) are organized in a non-overlapping finite hierarchy. This establishes generality and well-foundedness as two of the main requirements of a categorial ontological account that aims at being a foundational ontology" (Augusto, 2022, pp. 4-5), where he means that to refer to considering core distinctions in "ontological categories," such as between universal vs particular, substantial vs non-substantial, qualities or not, and so on. Augusto then claims that "we are often confronted with projects that are seen as foundational ontologies when in fact they do not satisfy these conditions" (*ibid.,* p. 5). We split this complaint up into two components: the kind of urelements and, within those, the categories that could be in a FO.

The first step would be to decide on some fundamental views and consequent "furniture" of the universe. Most FO developers did so to some extent, as has been described in the documentation related to the respective FOs; e.g., 3-dimensionalism vs 4-dimensionalism and whether it concerns universals or concepts. One factor that they did gloss over, is the limitations imposed by the logic they used to represent the FO and the ontological decisions embedded within it (Fillottrani & Keet, 2020). For instance, first order predicate logic does not distinguish between universals and relational qualities or universals and concepts–they are all just mere predicates–and does take the stance for the so-called "standard view" on relations (cf. "positionalist" or "anti-positionalist" (Fine, 2000). If one wants such fundamental distinctions, a new logic must be defined, which neither of the FO developers did. Assessed with philosophical glasses on, one can hold them accountable for this gap in the documented FO design decisions. With engineering glasses on, such perceived to be required precision it would demand, like a many-sorted logic or a second-order logic, mostly negatively affects any chances of practical use except for the positionalist stance that is commonplace in conceptual data modelling.

Most FOs are all very similar in those fundamental representational aspects, such as settling for the 3-dimensionalist view. They also mention one philosophical theory or another, which is, to a certain extent, reflected in the representation of the entities. A descriptive ontology such as DOLCE allows entities that are dependent on human thoughts and beliefs to be represented while a realist ontology such as BFO aims for the representation of entities that are free of that. DOLCE is an ontology of particulars, whereas BFO is an ontology of universals and with this ideology, entities must have instances. However, practically, if an ontology developer were to merge ontologies with such conflicting philosophies, it would not pose a problem. The entities can co-exist having `owl:Thing` as a top node and the rest of the DOLCE and BFO taxonomy exist as OWL classes, since one cannot enforce in the logic whether entities in an ontology must have instances or not. In practice, the ontology language/logic is agnostic about such philosophical considerations.

3 Operationalising Those Categories

There are situations where actual or possible differences in philosophical viewpoint and content do matter. An aspect that emerged in the empirical evaluation of FO use (Keet, 2011), were challenges in aligning one's domain entities to the appropriate category in a FO without the manual help of the philosopher, deciding on which relations there were to use, how to structure the main entities in a hierarchy, and which of the FOs to pick. A FO can assist solving some of these design issues in ontology development. This requires the ontology developer to investigate ontological commitments, modelling choices, and other pre-requisites before selecting one of the several existing FOs. To assist with this selection, there are several artefacts, e.g., the ONSET foundational ontology selection tool (Khan & Keet, 2012), the BFO classifier [1], and comparative reports (for the most recent one, see Partridge et al., 2020). ONSET is a tool that features five "ontology developer perspectives" categories that are used to automatically calculate an appropriate FO, to choose, among others, ontological commitments, the language it is represented in, or the ontology ecosystem around it. For instance, selecting ontological commitments "eternalist, endurantism, use of general extensional mereology, actualism, multiplicative, realist, universals" among the multiple-choice questions returns as best option BFO, but it cannot meet the "multiplicative" and "GEM" requirements that DOLCE does meet (but it does not commit to universals). For detailed comparison on the actual content, it is possible to query alignments and conflicts of the actual contents of BFO, DOLCE and GFO in the repository of FOs, ROMULUS (Khan & Keet, 2016). Seemingly the same category easily can result in a clash. For instance, BFO, GFO, and DOLCE all have "temporal region," which in their respective descriptions sound like they mean the same thing. However, their placement in their respective taxonomies differ (as spacetime, occurrent, or abstract), which would result in inconsistencies if they were to be integrated. Whether these were firm ontological convictions or crept in as an encoding artefact is not fully clear. Perhaps it serves to reassess those over running off to develop yet another FO.

With the BFO classifier to assist a user to figure out what kind of entity they have, branches in the taxonomy are traversed based on the answers to questions that determine the appropriate subclass. For instance, "may the entity be copied between a number of bearers? (Y/N)"; if yes, then it is a generically dependent continuant in BFO; if not, then it is a generically dependent continuant. It is less straightforward when one has to decide between three siblings, since then either at least two Y/N questions are needed, or the answer needs to use some terminology of which the meaning remains intuitive. For instance, to determine the appropriate subclass of "Material entity" in BFO, which can be object, object aggregate, and fiat object part, and to distinguish between the four subclasses of `bfo:occurrent`.

What perhaps seems to be mere tool support actually demands laying bare also the implicit choices and it reveals any lack of clarity in the design or documentation. Among others: which features the FOs should be compared on and whether an answer to that can be found, whether some characteristics are more important, and how to devise a good question for a decision diagram to accurately distinguish between siblings in a hierarchy, which requires there to be explicit desiderata and a clear distinguishing characteristic between the siblings.

4 Concluding Remarks

While the notion of categories of kinds of elements to devise a FO indeed deserve more attention than they received to date, from a practical viewpoint, using a FO–any one of them–is better than none. Furthermore, trying to actually use them in domain ontology development may reveal implicit FO design decisions, which then can either improve the documentation and tooling support or spur updates to the FOs used.

References

Arp, R., Smith, B. & Spear, A. D. (2015). *Building ontologies with Basic Formal Ontology*. MIT Press.

Augusto, L. M. (2022). Categories and foundational ontology: A medieval tutorial. *Journal of Knowledge Structures & Systems*, *3*(1), 1-56.

Fillottrani, P. R. & Keet, C. M. (2020). An analysis of commitments in ontology language design. In B. Brodaric & F. Neuhaus (eds.), *Proceedings of the 11th International Conference on Formal Ontology in Information Systems 2020*, FAIA vol. 330 (pp. 46-60). IOS Press.

Fine, K. (2000). Neutral relations. *Philosophical Review*, *109*(1), 1-33.

Guizzardi, G., Benevides, A. B., Fonseca, C., Porello, D., Almeida, J. P., & Sales, T. P. (2022). UFO: Unified Foundational Ontology. *Applied Ontology* (in press).

Herre, H. (2010). General Formal Ontology (GFO): A foundational ontology for conceptual modelling. In R. Poli, M. Healy, & A. Kameas (eds.), *Theory and applications of ontology: Computer applications* (pp. 297-345). Springer.

Keet, C. M. (2011). The use of foundational ontologies in ontology development: An empirical assessment. In G. Antoniou et al. (eds.), *Proceedings of the 8th Extended Semantic Web Conference*, LNCS vol. 6643 (pp. 321-335). Springer.

Khan, Z. & Keet, C. M. (2012). ONSET: Automated Foundational Ontology Selection and Explanation. In A. ten Teije et al. (eds.), *Proceedings of the 18th International Conference on Knowledge Engineering and Knowledge Management*, LNAI vol. 7603 (pp. 237-251). Springer.

Khan, Z. C. & Keet, C. M. (2016). ROMULUS: A Repository of Ontologies for MULtiple USes populated with foundational ontologies. *Journal on Data Semantics*, *5*(1), 19-36.

Masolo, C., Borgo, S., Gangemi, A., Guarino, N. & Oltramari, A. (2003). Ontology library, WonderWeb Deliverable D18, ver. 1.0, 31-12-2003.

Partridge, C., Mitchell, A., Cook, A., Leal, D., Sullivan, J., West, M., CDBB. (2020). *A survey of top-level ontologies - to inform the ontological choices for a Foundation Data Model*. DOI: https://doi.org/10.17863/CAM.58311.

Verdonck, M., Gailly, F., Pergl, R., Guizzardi, G., Franco Martins, B., & Pastor Lopez, O. (2019). Comparing traditional conceptual modeling with ontology-driven conceptual modeling: An empirical study. *Information Systems*, *81*, 92-103.

Online Resources

[1] https://bfo-classifier.github.io/

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