Notes to Commentators on the Paper
An Extendible Realism-Based Ontology for Kinship
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<u>*Responses to Reviewer 1*</u>

SCORE: 3 (strong accept)
This paper presents an ontology for kinship aligned with BFO, axiomatized in FOL and provided in CLIF format, including bridging axioms with SNOMED CT as well as an extra module including axioms that are not literally true but describe generalities that may have exceptions, and thus can be used to generate alerts on possible data entry mistakes. The ontology is mostly inspired by the ontology of Chui et al. (2020) (ref [17]) and the paper describes how to adapt it to the realist BFO framework.
The paper is very clear and well-structured. It proposes an instructive coverage of existing ontologies in section 4. The methodology to convert a non-realism-based ontology into a realism-based one is instructive. The ontologies are available in online open-access, including a useful document to visualize the changes between the original T_kinship ontology and its adaptation.

➔ We thank the reviewer for these nice comments.

I found the extra module especially interesting and it would be great to have more suggestions in the discussion section about how to deal in general with axioms that are literally true vs. those that are "often true". For example, how could such an approach be used in an ontology of canonical anatomy? A human body has usually two arms, but not always – so should an axiom stating that every human body has two arms be formalized in such an extra module?

➔ We think that this is an excellent suggestion and that acting on it could often serve valuable data-entry and data-inspection purposes. Elaborating on it, specifically with respect to canonical anatomy, is however outside the scope of this paper.

This is an excellent paper, and I see only two limits:
- The first one is that the ontological work is not massively original, since it is mainly an adaptation and correction of an existing kinship ontology into the BFO-based realist framework. But this adaptation process is in itself an interesting work that was performed very rigorously and clearly and is for me definitely instructive enough to warrant publication.

➔ Yet, we are not aware of any other example of an existing ontology being re-used in this way. All BFO-compatible ontologies thus far have been created de novo and none of these have been axiomatized in FOL.

- The second one is that the paper does not mention the complexities brought by the gender/sex distinction (is an aunt someone who has a feminine gender or a female biological sex? The ontology seems to opt for the second solution as suggested on p. 6, but does not discuss this choice), nor the difficulties to classify gender (including non-binary persons) or biological sex (phenotypical sex, genotypical sex, etc. including intersex persons).
And what about non-gendered kinship terms that have been sometimes suggested such as "auncle"? Some comments would be needed about the choices that have been made here and alternative possible options (see e.g. https://ceur-ws.org/Vol-3073/paper1.pdf for some thoughts on the ontological nature of gender in a BFO context)

➔ Reviewer 1 correctly notes that we do not discuss the gender/sex distinction. We omit any such discussion primarily because the immediate use-case discussed in the paper does not require addressing it; as we indicate (admittedly briefly) on p. 5, the *relative* terms on the CCA-01 form other than 'spouse' carry blood-relative senses.

I have a few minor additional comments as presented below.

p. 2: "For something to be a realism-based ontology is for it (1) to be a representation of what is generically the case for a plurality of entities in reality, and (2) to be built out of smaller representations each one of which must be faithful to reality.": I am not sure to understand why the character of being "built out of smaller representations" is part of the realism-based ontology.

➔ It is not so much *'built out of smaller representations'* that is characteristic for the realism-based approach, but '*built out of smaller representations <u>each one of which must be faithful to reality</u>*'

Also, the realism-inspired definition of ontology in Arp, Smith and Spear (2015) [ref 6] is the following: "a representational artifact, comprising a taxonomy as proper part, whose representations are intended to designate some combination of universals, defined fined classes, and certain relations between them." This is not exactly in line with the definition proposed here and thus some comments about those differences could be useful.

➔ Both definitions are completely in-line. The definition in ref 6 is followed by 5 pages of more detailed explanation: it is in particular the paragraph '*representational units and composite representations*' in ref 6 that clarifies the complementarity of the two definitions.

p. 4: Is it ethically acceptable to spoil a movie to the reader for the purpose of illustration in a scientific paper? :-)

➔ We didn't tell which character, did we?   :-)

p. 5: Ref [26] is not available on a written form (as it seems), so it would be useful for the reader who is not familiar with the notion of Kowalski-rule base to have a publicly available reference.

➔ We agree. We added the following explanation to the text: 'Kowalski rules are a further transformation of FOL axioms after they have been translated into clausal normal form. Kowalski rules are logical implications of which the antecedent is formed by conjoining the atoms of the negative literals in a clause, and the consequent from the disjunction of the positive literals.' We also added the following extra reference: Kowalski, R. (1974) Predicate Logic as a Programming Language. Information Processing, North Holland Publishing Co., Amsterdam, 569-574.

p. 4: "In general, rewriting accepted axioms for BFO2020-compatibility is needed whenever an axiom in the kinship ontologies considered treat cases of some individual's instantiating a universal at a time as cases of this individual's standing in some timeless unary relation (as in FOL) or as cases of some individual's timelessly being a member of a class (as in OWL).": This sentence was originally a bit difficult to understand for me and might be rewritten/expanded.

➔ We changed the sentence as follows: 'In general, any axiom in a source ontology that describes an individual as timelessly standing in some unary relation (as in FOL '*fantologically conceived*') or as timelessly being a member of a class (as in OWL) requires revision for BFO2020-compatibility during Step 2. This is because under a realism-based perspective, such an individual is very likely a particular which instantiates at a time a universal.'
This is why, for example, during Step 2 we rewrote (A3) (which treats a case of an individual's instantiating personhood at a time as a case of this individual's timelessly standing in the unary personhood relation) as (A4).

p. 6: "In our axioms, the expression 'male-sex' _picks out the sex had by males qua males, and 'female-sex' _picks out the sex had by females qua females.": I don't understand why the "qua" restriction is needed here. It seems to me that 'male-sex' picks out the sex had by males, period (same for female).

➔ This was indeed a confusing passage on our part, and some explanation has been added. We have included the "qua" restrictions for the following reason: An organism with *simultaneous hermaphroditism* at t has male sex and female sex at t. It follows that there is no sex that can be referred to simply as "the sex had by males" for there are males with two sexes. However, there is just one sex had by males *insofar as they are males*:

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Even a simultaneous hermaphrodite has male sex and only male sex *insofar as it is male* (and similarly, mutatis mutandis, for female sex and being female). This is the point the qua restriction is meant to capture. We made this clearer in the paper by adding the following passage to the end of the paragraph: "We insist that 'male-sex' picks out the sex had by males *qua* males, not the sex had by males *simpliciter* (and similarly, *mutatis mutandis*, for 'female-sex' and females). *Simultaneous hermaphrodites* (e.g., great pond snails) are male and female at the same time. It follows that there is no such thing as *the* sex had by males *simpliciter*, for some males have multiple sexes. But even a simultaneous hermaphrodite has the male sex, and only the male sex, *qua* male. Hence our insistence on the "*qua*" restriction."

p. 6: "We also assume that if x has spouse y, then there is a marriage bond that inheres in x and y and that exists at a time at which x and y exist. This assumption secures the intuitively correct verdict that spousehood is a temporal matter; people are not simply atemporally spouses of one another, even if natural-ancestry relations are simply atemporal": This seems to belong to 7.1.

➔ It is true that much of our discussion of time-indexing occurs in 7.1, but here we are elucidating some of the foundational relations in our ontology, and the has-spouse relation is one such relation. For this reason we'd prefer to keep this passage in its present place.

p. 7: "One way to accommodate an element of time-indexing concerning has-spouse is to time-index has-spouse itself; another is to attach time-indexing to something that one's ontology holds to be inextricable from spousal relations. We took the latter approach, by maintaining that x has spouse y if and only if there is a marriage bond – a specialization of BFO2020's relational quality – that exists when x and y do and that inheres in x and y."
I must say it has never been clear for me why some relations are reified in the BFO framework, and how to chose the ones that are reified vs. the ones that are not. A few additional justifications about the rationale for chosing the second possibility rather than the first (as mentioned in the text) would be useful.

➔ BFO uses reality as benchmark: the guiding principle is existence. Existence applies only to entities (universals and particulars). Formal relations do not exist as entities; there are no universals that formal relations are instances of. Material relations do, examples being relational processes (kissing) and relational qualities (marriage bond). This is explained in Chapter 5 of ref 6, 'marriage bond' being precisely the example used for relational quality. We added the reference to the paper.
As a further note, 'reification' goes against the grain of BFO as it means turning a relation into an entity. Reifying in an ontology intended to be BFO compatible would be making a mistake. At the other hand, it is allowed to define 'shortcut' relations, i.e. formal relations defined in terms of other relations. That is what our has-spouse relation actually is, given the relation we say it has to the marriage-bond relational quality.

Responses to Reviewer 2
SCORE: 2 (accept)
****General comments****
This paper aims to develop an ontology for kinship in first-order logic (FOL) in compliance with Basic Formal Ontology (BFO) --- which adopts the methodology of ontological realism (Section 2) --- or more specifically with the FOL axiomatization of BFO (i.e. BFO2020-FOL). The motivating example is the medical case of cholangiocarcinoma, as it is a serious health problem in Thailand (Section 3). Existing kinship ontologies are critically examined, in addition to SNOMED-CT, which includes the terms for kinship (Section 4). The methodology for developing a BFO- and realism-based ontology for kinship using kinship terms in SNOMED-CT is explained (Section 5). As a result, a kinship ontology composed of six modules is developed and it is publicly accessible (Section 6). The discussion (Section 7) and the conclusion (Section 8) are provided.

I think that the paper is well-structured, the kinship ontology (especially the "ancestry.clif module" thereof) developed by the authors includes the core axioms representing kinship relationships, and it constitutes the first steps towards a full-fledged realism-based ontology for kinship that is compatible with BFO. I am not an expert on the ontology or representation of kinship, but my overall evaluation is that this paper can be accepted for the presentation in the ICBO2023 conference.

***Specific comments ***
(Note: They are mostly minor.)
Abstract
- "Common Logic Interface Language (CLIF)". The word "Language" should be replaced by "Format".

→ Correct! We changed this.

Section 1
- It would be helpful to specify the organization of the paper at the end of Section 1 (cf. the first paragraph of my ***General Comments***).

→ We did. We added the following text: 'In Section 2, we explain realism-based ontology. In Section 3, we describe a use-case for our ontology, from which some of the relations in our ontology are derived. Section 4 contains a review of several extant kinship ontologies, including the one from which ours is primarily adapted. We describe our methodology in Section 5 and detail the results of our project in Section 6. Further discussion, including of some of the more important design choices we made, appears in Section 7. Section 8 contains concluding remarks.'

Section 2
- Lines 1-3. It may be better to refer to the role of scientific description in explaining realism-based ontologies or ontological realism. (Cf. "(…) to view ontologies as representations of the reality that is described by science" [7])

→ We think that this characterization would be less precise than the one in the paper, as it would imply that most scientific papers qualify as ontologies.

Section 3
- Lines 3-4 from the bottom. "When positively answered" -> "When this question is positively answered". Otherwise, it would mean: when the following options are positively answered.

→ Corrected as suggested.

Section 5- (About Section 5 and later sections.)
I am not always very clear about the terms "unusual situations" and "unusual relations". I may appreciate some terminological clarification. For instance, does your term "unusual" generally correspond roughly to the term "counterintuitive" or another term?

→ This is a good question, and we appreciate the opportunity to respond to it. We do not mean by "unusual" *counterintuitive*. For example, a spousehood relation between first cousins is not, in our view, *counterintuitive*, though we mark such a relation as unusual. A better gloss on "unusual" is *atypical*. Spousehood relations between first cousins are atypical—they just don't happen very often. Furthermore, they happen sufficiently infrequently that an unusualness axiom pertaining to them seems to serve valuable data-entry and -inspection purposes. We emphasize that "unusual," as we use it, is not meant to carry any normative weight. In calling a relation "unusual," we do not mean to imply that it is bad, that it ought to be illegal, or that any other such normative fact obtains.

We added the following paragraph: We note that we do not mean by "unusual" *counterintuitive*. For example, a spousehood relation between first cousins is not, in our view, *counterintuitive*, though we mark such a relation as unusual. A better gloss on "unusual" is *atypical*. Spousehood relations between first cousins are atypical—they just don't happen very often. Furthermore, they happen sufficiently infrequently that an unusualness axiom pertaining to them seems to serve valuable data-entry and -inspection purposes. We also emphasize that "unusual," as we use it, is not meant to carry any normative weight. In calling a relation "unusual," we do not mean to imply that it is bad, that it ought to be illegal, or that any other such normative fact obtains.

Section 6
- Line 1. I am not sure what it means to say that modules are "partly dependent on each other". Do you mean, for instance, that they partly *overlap* each other?

➔ We rephrased the first paragraph of section 6 in this way: 'Our kinship ontology consists of six modules. Some modules contain axioms whose definientia refer to relations or entities defined in other modules. However, some modules can be ignored when irrelevant for certain applications. That is for instance the case for the bridging axioms to SNOMED CT when SNOMED CT is not used in an application the ontology intends to serve.'.

Section 7
- Section 7.2. I am not sure whether I understand well the sentence of the first paragraph: "The approach thereto is …". In my view, this paper aims to develop a realism-based ontology for kinship by using the terms in SNOMED-CT that represent kinship relationships (cf. My ***General Comments*** above). But the sentence seems to imply that you intend to develop "one *logical* model-theoretic framework" rather than "one *ontological* framework". For instance, does your kinship ontology refer to a logical *model* on the assumption (as taken by some ontology researchers) that an ontology is a logical *theory*? Clarification on this point would be needed.

➔ We see where the problem in understanding comes from. In section 7.2. we are referring exclusively to the part of our kinship ontology that is intended to be a bridge to and from SNOMED CT. It is thus NOT the case that our entire kinship ontology is based on SNOMED CT. The 'logical model-theoretic framework' we are referring to is covered in a paper we forgot to cite and which introduces a method to create axioms which combine a concept-based view – in concreto SNOMED CT – with a realism-based view – in concreto BFO and OGMS. Section 7.2. thus provides explanation on those axioms of our kinship ontology which serve to fit in that framework. We changed the corresponding section to make this clear.

- Section 7.3. The paragraph before (A13). As for the expression "It and the other axioms", "This axiom and the others" may be preferred.

➔ This change is made.

Section 8 - It may be better to give some brief remarks on future work at the end.

➔ We added the following sentences to the end of the section: In future work, we intend to expand on this project by adding SNOMED CT kinship concepts that we have not yet wedded to our kinship ontology, either through definitions of corresponding relations or through production of relevant bridge axioms. Further expansion following the same bridging strategy might happen when other relevant kinship terminologies become prominently used.