

Release notes for the BFO 2 2012-07-20 'Graz' OWL Release

This document is: <http://purl.obolibrary.org/obo/bfo/2012-07-20/ReleaseNotes>

These release notes are about the OWL document <http://purl.obolibrary.org/obo/bfo/2012-07-20/bfo.owl> an RDF/XML document, which is the BFO 2 OWL "Graz" release of 2012-07-20. The version of the BFO 2 Reference on which this is based is <http://purl.obolibrary.org/obo/bfo/2012-07-20/Reference>

This version of BFO represents a major update to BFO and is not backwards compatible with BFO 1.1. The previous version of BFO, version 1.1.1 will remain available at <http://ifomis.org/bfo/1.1> and will no longer be updated. We expect to provide automated support for migrating from BFO 1.1 to BFO 2 at some point in the future.

This version is a draft release for public comments. As such we expect it to generate a lively discussion rather than be a stable ground for building application ontologies. The release is the product of intensive discussions and a series of prototypes which kicked off with a November 2011 workshop held in Buffalo.

While we have attempted to produce a file reflecting the current BFO2 specification document, there may be issues or bugs that will be fixed in subsequent releases. Our expectation is that IDs in this version, going forward, will not disappear and we will follow the GO/OBI deprecation policy. In addition, not all elements of the reference itself are stable and there may be (even substantial) changes to the reference before we have the first release candidate.

The release will be officially disclosed at the upcoming BFO 2.0 workshop, to be held at [ICBO FOIS 2012](#) in Graz (Austria). It is therefore named the "Graz release".

The latest version of BFO will always be at <http://purl.obolibrary.org/obo/bfo.owl>

The unreleased version under current development is at: <http://purl.obolibrary.org/obo/bfo/dev/bfo.owl>

We invite all interested parties to submit issues on the tracker at <http://purl.obolibrary.org/obo/bfo/tracker> and/or send feedback to the BFO OWL development group at: <https://groups.google.com/forum/?fromgroups#!forum/bfo-owl-devel>

About Basic Formal Ontology (BFO)

BFO, the Basic Formal Ontology, grew out of a philosophical orientation, which overlapped with that of DOLCE and SUMO. Unlike these, however, it is narrowly focused on the task of providing a genuine upper ontology to be used in support of domain ontologies developed for **scientific research**, as for example in biomedicine within the framework of the [OBO Foundry](#), a library ontologies for biology and medicine. Thus

BFO does not contain any term which would properly fall within the special sciences domains.

The BFO project was initiated in 2002. The theory behind BFO was initially developed by Barry Smith and Pierre Grenon. Important contributions to BFO have been made by many people, including: Werner Ceusters, Chris Mungall, Fabian Neuhaus, Holger Stenzhorn, Alan Ruttenberg, Mathias Brochhausen, Bjoern Peters, Kerry Trentelman, and by more than hundred other members of the BFO Discussion Group.

The BFO versions 1.0 and 1.1 were limited to taxonomic hierarchies of mutually exclusive nodes, representing domain-independent universals.

Now, ten years after BFO's first steps, a new and significantly enhanced version is in the final stage of its development. While BFO 2 maintains most of the original taxonomic structure, it additionally adds a set of relations and related axioms.

There are three sources that define BFO 2:

1. the BFO 2 Reference: This is a text document that extensively describes the ontology using English text, enhanced by formal definitions. This document is currently available at <http://purl.obolibrary.org/obo/bfo/2012-07-20/Reference>
2. BFO 2 in first order logic (CLIF format). This version is still under development.
3. BFO 2 in OWL DL. The Graz version can be accessed at <http://purl.obolibrary.org/obo/bfo/2012-07-20/bfo.owl>

The three versions share their free text and logical definitions and elucidations, as well as examples from various scientific domains. Axioms are identified by unique identifiers referred to by the different formats as identified in the specification document.

The BFO home page is <http://purl.obolibrary.org/obo/bfo>. From that page you can access our repository and information about the development processes, mailing lists, etc. Note that the previous BFO Home page at

<http://www.ifomis.org/bfo> represents work prior to BFO 2 and that we will be consolidating the two sites in the near future.

Collaborative development process

The development process of BFO2 is collaborative. With the current release BFO 2 is disclosed to a wider community. All kinds of contributions, critique, and term suggestions are highly appreciated and new community representatives are welcome. The following instruments for discussion and collaborative development can be used by the community:

- The BFO2 OWL issue tracker: <http://purl.obolibrary.org/obo/bfo/tracker>
- The BFO2 developers discussion list: bfo-devel@googlegroups.com
- The BFO2 OWL developers discussion list: bfo-owl-devel@googlegroups.com
- The BFO user discussion list: bfo-discuss@googlegroups.com
- For those that wish to be kept aware of developments in real time, a mailing list which reports commits to the repository is at <http://groups.google.com/d/forum/bfo-svn-commit>

A summary of the design principles for the OWL version is described at [Proposal for how we manage OWL Reference coordination](#). A description of some aspects of the development process is at [How we](#)

[record issues and resolutions.](#)

General:

There are many changes since the last release (BFO 1.1). As such these notes may omit some aspect of these changes. Please refer to the BFO reference once you have read this summary of the most significant changes:

- Addition of relations and axioms using these relations
- Sibling classes are no longer required to be mutually exclusive (in at least one case)
- Subclasses of BFO:Material Entity are not intended to be exhaustive
- New simplified treatment of boundaries and regions
- Treatment of process predications under the heading 'process profiles'
- Addition of class history, a process subtype that is in a 1:1 relation between a material entity via the has-history relation.

OWL-Specific

The OWL version uses the [direct semantics](#) and does not restrict expressivity to any of the [profiles](#). It contains (i) a taxonomy of classes, and (ii) a taxonomy of object properties. There are no datatype properties or particulars. Each term is systematically annotated using annotation properties that are collected from a number of sources, including the [draft BFO2 Reference](#).

Classes:

OWL classes correspond to the extensions of universals as given by the BFO2 specification. All members of BFO OWL classes are particulars. For instance, all members of the class Process instantiate the universal Process at any time of their existence. There are no closure axioms for sibling classes. We have attempted to provide, as editor notes, the reasons for not having closure axioms.

Object Properties

In this version of BFO, relations that were formerly in the relation ontology, but which were essential for defining and understanding BFO, are now part of BFO proper.

OWL object properties are, by definition, binary properties, and we use them to represent relations between particulars. This precludes using them to represent relations between particulars and universals or between universals and universals, at least without some kind of coding that is outside the OWL DL semantics.

'is a' and 'instance of' are presented as relations in the BFO Reference. However, we use the built in properties `rdfs:subClassOf` and `rdf:type` instead of using object properties in order to take advantage of the computational abilities associated with OWL. While `is_a` is binary, 'instance of' is time indexed. Thus we only instantiate "rigid" classes, as the interpretation we take is a `rdf:type C => forall(t) a exists at t -> a instance of C at t`. Temporally restricted instantiation is not supported in this version of BFO in OWL. We are working on it for the future. For example, the assertion that x is a professor at just those times when a professor role inheres in x, can not be stated explicitly in the current version.

Other properties that are time-dependent in the BFO Reference are handled in OWL so as to have a FOL

reading according to BFO. We use two patterns exemplified in the next two definitions:

$x \text{ rel-at-some-time } y \rightarrow \text{exists}(t) \text{ exists_at}(x,t) \rightarrow \text{exists_at}(y,t) \text{ and rel}(x,y,t)$
 $x \text{ rel-at-all-times } y \rightarrow \text{forall}(t) \text{ exists_at}(x,t) \rightarrow \text{exists_at}(y,t) \text{ and rel}(x,y,t)$

Not all temporal object properties have both the -at-some-time and at-all-time relations. Instead the working group selected a subset of the possibilities that by their judgement seemed adequate. Comments on that choice are particularly welcome.

For example, the relation inheres in at some time is omitted, because, by definition, a specifically dependent continuant only inheres in the same bearer during all of its existence.

Due to the inclusion of time into the definition of object properties the original FOL definition of inverse relations are only maintained for the “at-some-time” pattern, except in the case of continuant part of, where we have tentatively included -at-all-times inverses for evaluation of whether GO considers them important. Briefly, those relations are:

part of continuant at all times inverse: has continuant part at all times that object exists
has continuant part at all times inverse: part of continuant at all time object exists

It is important to note:

part of continuant at all times **is NOT the inverse of** has continuant part at all times

A rather large change is the splitting of the former has part relation into binary and ternary versions. The part relations between occurrents are binary and those between continuants are ternary, time indexed relations. An important general principle that was applied was that different relation types should not be overloaded on a single relation. So in the previous version of RO/BFO, part_of was the name of a class level relation, a binary relation among occurrents, and a time-indexed relation between continuants. In the current version we have dropped the class-level relations and have given distinct names for properties that were previously overloaded.

Axioms

Axioms can be found at different levels:

- At class level: necessary (subClassOf) as well necessary & sufficient (equivalentTo) conditions; disjointness axioms (disjointWith)
- At object property level: domain / range restrictions, inverse relations, transitivity
- Globally: General class axioms (which do not have an atomic symbol at their left side)

Note that not all axioms from the specification and the FOL version can be translated into OWL-DL. Some axioms (e.g. equivalence of relations) have therefore been translated into a weaker variant. For example we say every material entity occupies spatial region at some time some spatial region. In this case we would prefer to say that:

at every time that a material entity exists there exists some spatial region that it occupies.

Our current temporalized relations are not able to express this generic kind of relation. We are considering various approaches that might ameliorate this.

Note that the axiomatization is not yet complete. We need to, at least, do a careful review of the axioms in

the [BFO2 Reference](#) and exhaustively identify those which can be included (or at least approximated). We haven't yet ensured that all axiom ids are appropriately linked - we aim, in the longer term, for the CLIF axiom id to be annotated as an axiom annotation on the OWL axiom that encodes all or part of the FOL axiom from the CLIF file. We haven't yet reviewed which axioms are absent from the Reference and CLIF but present in the OWL version, and which should therefore be included in those documents.

Reviewers of both documents are encouraged to submit issues that note discrepancies between reference and OWL or any other issues related to the axiomatization.

Annotations

BFO 2.0 includes the following annotation properties:

- BFO CLIF specification label: label used in the FOL version
- BFO OWL specification label: label used in the OWL version
- Editor note: Additional information, either taken from the BFO2 Reference, or members of the working group, that help document the term.
- has associated axiom(fol): associated first order axiom, written in CLIF, including a reference tag of the format [nnn-nnn]
- has associated axiom(nl): associated axiom, written in English, including a reference tag of the format [nnn-nnn] (taken from the BFO2 Reference)
- elucidation: Primitive terms in a highest-level ontology such as BFO are terms which are so basic to our understanding of reality that there is no way of defining them in a non-circular fashion. For these, therefore, we can provide only elucidations.
- definition: necessary and sufficient conditions for a class or relation, written in English
- example of usage: examples of usage of a term, often an exemplar
- isDefinedBy: the IRI of the ontology in which the term is maintained. For BFO 2 it is always the URI of the BFO ontology.
- label: the label used for display in graphical editors, followed by a language tag.

There is a provision for adding editorial notes by individuals or groups. Please contact us if you would like to contribute notes and so take advantage of this capability.

Finally, there are a number of annotations that are attached to the ontology proper - ontology annotations.

Issues

There are several issues that have been repeatedly discussed since the kickoff of the BFO 2 project. Most of them are documented on the issue tracker: <http://code.google.com/p/bfo/issues/list>. It is our intention that reviewers of this version similarly file issues on the tracker.

Current open issues include (among others)

- Naming: appropriate, intuitive, non confusing to users
- The exact meaning of universals, e.g. object_aggregate vs. object, with regard to identity and disjointness
- Discussion of coherence of new elements of BFO e.g. process profile
- Compatibility with BFO 1.1, regarding the obsolescence of representational units
- Compatibility and continuity wrt the relation ontology, both its previous version and its new

incarnation as a depository for useful and shortcut relations.

- Alternative approaches to treating ternary relations as binary ones, e.g. by introducing temporally qualified continuants (as *façon de parler*) to represent non-rigid universals.
- Appropriateness and adequacy of metadata.

Statistics

Classes: 36

Object properties: 78

Subclass axioms: 105

EquivalentClass axioms: 14

DisjointClasses axioms: 11

General Class inclusions: 12

SubObjectPropertyOf: 65

InverseProperty: 24

TransitiveObjectProperty: 16

ObjectPropertyDomain: 56

ObjectPropertyRange: 60

SubPropertyChainOf: 2

AnnotationAssertion: 1197

BFO IDs that are used by [ro.owl](#) (from [bfo-ruttenberg.owl](#))

Below is a compilation of id correspondence between owl-ruttenberg, upon which the current OBO2OWL translation is based, and the new version of BFO 2. It is intended to be reviewed by Chris Mungall, David Osumi-Sutherland, Jane Lomax, and others related to the OBO2OWL effort in order to assess whether we should change any of the ids currently used in BFO 2 so that they won't conflict with the meaning that the OBO2OWL assumed.

Relations

- (1) [BFO_0000050](#) *part of*, exists in owl-ruttenberg but not in bfo.owl
- (2) [BFO_0000051](#) *has part*, exists in owl-ruttenberg but not in bfo.owl
- (3) [BFO_0000052](#) *inherits in*, exists in owl-ruttenberg as *inherits in* and in bfo.owl as *inherits in at all times*
- (4) [BFO_0000053](#) *is bearer of*, exists in owl-ruttenberg as *is bearer of*, and in bfo.owl as *bearer of at some time*
- (5) [BFO_0000054](#) *is realized by*, exists in owl-ruttenberg as *is realized by* and in bfo.owl as *realized in*
- (6) [BFO_0000055](#) *realizes*, exists in owl-ruttenberg and bfo.owl
- (7) [BFO_0000056](#) *participates in*, exists in owl-ruttenberg as *participates in* and in bfo.owl as *participates in at some time*
- (8) [BFO_0000057](#) *has participant*, exists in owl-ruttenberg as *has participant* and in bfo.owl as *has participant at some time*
- (9) [BFO_0000062](#) *is preceded by*, exists in owl-ruttenberg as *preceded by*, not in bfo.owl (likely to be

added)

(10) [BFO_0000063](#) *precedes*, exists in owl-ruttenberg as *precedes*, not in bfo.owl (likely to be added)

(11) [BFO_0000066](#) *occurs in*, exists in owl-ruttenberg and bfo.owl

(12) [BFO_0000067](#) *has site of*, exists in owl-ruttenberg as *has site of*. In bfo.owl its label was updated to *contains process* (synonym)

Classes

(13) [BFO_0000001](#) *entity*, exists in owl-ruttenberg and bfo.owl

(14) [BFO_0000002](#) *continuant*, exists in owl-ruttenberg and bfo.owl

(15) [BFO_0000003](#) *occurent*, exists in owl-ruttenberg and bfo.owl

(16) [BFO_0000004](#) *independent continuant*, exists in owl-ruttenberg and bfo.owl

(17) [BFO_0000007](#) *process*, existed in owl-ruttenberg. In bfo.owl, BFO:0000007 disappeared and was merged with BFO_0000015, *process*, which is *processual entity* in owl-ruttenberg. That's because we agreed that *process*, as the definition exists, was rarely if ever applicable (this is reflected in the usage RO makes of this relation, which has label *process* but definition of *processual entity*). Recommendation is that RO switches to using BFO_0000015, *process*. BFO_0000007 does not exist in bfo.owl.

(18) [BFO_0000040](#), *material entity*, exists in owl-ruttenberg and bfo.owl.

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The authors of this OWL version have attempted to follow, as closely as possible, the BFO specification. In many cases the limitations of OWL require OWL-specific adaptation and reinterpretation. In accordance with the collaborative development process the OWL version of BFO will undergo further evolution and can therefore not be considered stable. This document as well as the Reference and OWL ontology document are released under the [Creative Commons Attribution License Version 3. unported](#)

Contributors (alphabetical order)

The development of BFO 2 was contributed to by many people.

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We apologize for any omissions in the above lists. If you have been inadvertently omitted from the list of contributors, please bring it to our attention.

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