



Building Ontologies with Basic Formal Ontology

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- Obstacles to Accessibility: Human and Technical Idiosyncrasy
 - The Computer Limitations Problem
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 - An Example: The BRIDG Model
- Ontology as Part of the Solution
- A New Organon for the Information Age
- Suggested Further Reading

1 What Is an Ontology?

- Introduction
 - Ontologies Are Representational Artifacts
- Artifacts
 - Representational Artifacts
 - Representational Units and Composite Representations
 - A Note on "Term"

Ontology, Terminology, Conceptology
 Ontology and Terminology: The Case of ISO
 The Concept Orientation
 Philosophical and Historical Background to Conceptualism
 Realism and Ontology
 Accurately Representing Entities in Reality
 Respecting the Use-Mention Distinction

Ontologies Represent Universals, Defined Classes, and the Relations Between Them

The Goal of Science Is to Represent General Features of Reality
 Ontological Realism
 Metaphysical Nominalism
 Universals and Particulars
 Empty or Potentially Empty General Terms
 Universal vs. Class
 Relations in Ontologies
 Basic Relations
 Universal-Universal Relations
 Universal-Particular Relations
 Particular-Particular Relations

Conclusion

Further Reading on Issues of Epistemological and Ontological Realism

2 Kinds of Ontologies and the Role of Taxonomies

Philosophical Ontology

Philosophical Ontology and Taxonomy
 Simple Taxonomies
 Formal vs. Material Ontologies
 Domain Ontology
 Domain Ontology and Taxonomy
 Definition, Taxonomy, Ontology
 Top-Level Ontology
 Semantic Interoperability
 Choice of Top-Level Ontology

Application vs. Reference Ontology

Conclusion

Further Reading on Top-Level and Domain Ontology

Further Reading on Taxonomy and Classification

3 Principles of Best Practice I: Domain Ontology Design

General Principles of Ontology Design

1. Realism
2. Perspectivalism
3. Fallibilism
4. Adequatism

Additional Principles of Ontology Design

5. The Principle of Reuse
6. The Ontology Design Process Should Balance Utility and Realism
7. The Ontology Design Process Is Open-Ended
8. The Principle of Low-Hanging Fruit

Overview of the Domain Ontology Design Process

Explicitly Determine the Subject Matter of the Domain

Ontology

Domain and Top-Level Ontologies

Relevance

Granularity

The Problem of Nonexistents

Conclusion

Further Reading on Relevance, Perspectivalism, Granularity, and Adequatism

4 Principles of Best Practice II: Terms, Definitions, and Classification

Principles for Terminology

Gather and Select Terminology

1. Include in the terminology terms used by scientists
2. Strive to ensure maximal consensus with the scientists' usage
3. Identify areas of disciplinary overlap where terminological usage is not consistent
4. In terminology construction and ontology design, make use of as many existing resources (terminologies and ontologies) as possible.

Formatting Terminology

5. Use singular nouns.
6. Use lowercase for common nouns.
7. Avoid acronyms.
8. Associate each term in the ontology with a unique alphanumeric identifier.
9. Ensure univocity of terms.
10. Ensure univocity of relational expressions.
11. Avoid mass terms.
12. Distinguish the general from the particular.

Principles for Definitions

13. Provide all nonroot terms with definitions
14. Use Aristotelian definitions
15. Use essential features in defining terms.
16. Start with the most general terms in your domain.
17. Avoid circularity in defining terms.
18. To ensure the intelligibility of definitions, use simpler terms than the term you are defining.
19. Do not create terms for universals through logical combination.

20. Definitions should be unpackable (Term-definition intersubstitutability)

Principles for Taxonomies

21. Structure every ontology around a backbone *is_a* hierarchy.

22. Ensure *is_a* completeness.

23. Ensure asserted single inheritance.

24. Both developers and users of an ontology should respect the open-world assumption.

25. Adhere to the rule of objectivity, which means: describe what exists in reality, not what is known about what exists in reality

Conclusion

Further Readings on Definitions and Categorization

Examples of Critical Reviews

5 Introduction to Basic Formal Ontology I: Continuants

Some Basic Features of BFO

Basic Types of Entity: Continuant and Occurrent

BFO: Continuant

BFO: Independent Continuant

BFO: Material Entity

BFO: Object

BFO: Object Aggregate

BFO: Fiat Object Part

Combination Object-Entities

BFO: Specifically Dependent Continuant

BFO: Quality

BFO: Relational Quality

Relations That Do and Relations That Do Not Have Instances

BFO: Realizable Entity

BFO: Role

BFO: Disposition

BFO: Function

BFO: Specifically Dependent Continuant: Summary

Reciprocal Dependence among Realizable Dependent Continuants

BFO: Generically Dependent Continuant

BFO: Immaterial Entity

BFO: Continuant Fiat Boundary (including Zero-, One-, and Two-Dimensional Continuant Fiat Boundary)

Boundaries and Granularity

BFO: Site

BFO: Spatial Region (including Zero-, One-, Two-, and Three-Dimensional Spatial Regions)

Spatial Regions and Frames of Reference

A BFO Continuant Classification

Further Reading on Basic Formal Ontology

Further Reading on Granularity
 Further Reading on Independent Continuants
 Further Reading on Dependent Continuants
 Further Reading on Boundaries, Spatial Regions, and Topology

6 Introduction to Basic Formal Ontology II: Occurrents

BFO: Process
 BFO: History
 BFO: Process Boundary
 BFO: Spatiotemporal Region
 BFO: Temporal Region
 BFO: Zero-Dimensional Temporal Region
 BFO: One-Dimensional Temporal Region
 An Example of Occurrent Classification
 Classifying Universals with BFO
 Exhaustiveness of BFO Categories
 BFO's Perspectivalism
 BFO's Perspectivalism in Practice
 Further Reading on Processes and Events

7 The Ontology of Relations

BFO Relations
 Relations: Formal Properties and Conventions
 Primitive Instance-level Relations
 Universal-Universal Relations in BFO
 Foundational Relation: *is_a*
 Foundational Relations: *continuant_part_of* and *occurrent_part_of*
 Spatial and Temporal Relations
 Spatial Relation: *adjacent_to*
 Temporal Relation: *derives_from*
 Temporal Relation: *preceded_by*
 Participation Relation: *has_participant*
 Some Further Top-Level Relations
 proper_continuant_part_of and *proper_occurrent_part_of*
 has_continuant_part and *integral_continuant_part*; *has_occurrent_part*
 and *integral_occurrent_part*
 Relations and Definitions of Categories
 The All-Some Rule
 Inversion and Reciprocity
 Some Examples of Axioms
 Reflexivity, Symmetry, and Transitivity
 Further Reading on Relations

8 Basic Formal Ontology at Work

The Protégé Ontology Editor and BFO
 The Web Ontology Language (OWL)

Hypertext Markup Language (HTML) and Extensible Markup Language (XML)

Resource Description Framework (RDF)

RDF Schema (RDFS)

Simple Protocol and RDF Query Language (SPARQL)

Basic Features of OWL

OWL vs. Standard Relational Databases

OWL 2

Building Ontologies with Basic Formal Ontology

Example: The Ontology for General Medical Science (OGMS)

Infectious Disease Ontology (IDO)

Information Artifact Ontology (IAO)

The Emotion Ontology (MFO-EM)

Facilitation of Interoperability

Further Reading in OWL, RDFS, and RDF

Appendix on Implementation: Languages, Editors, Reasoners, Browsers, Tools for Reuse

Glossary

Web Links Mentioned in the Text

Notes

Bibliography