ISO/IEC ~~JTC 1/SC 32 N~~

~~2022-11-01~~

~~ISO/IEC FDIS~~ 21838-4:2023(E)

ISO/IEC JTC 1/SC 32/WG2

2023-05-24

Information technology — Top-level ontologies (TLO) — Part 4: TUpper

~~Warning~~

~~This document is not an ISO International Standard. It is distributed for review and comment. It is subject to change without notice and may not be referred to as an International Standard.~~

~~Recipients~~

Style Definition: Heading 2: Outline numbered + Level: 2 + Numbering Style: 1, 2, 3, … + Start at: 1 + Alignment: Left + Aligned at: 0 pt + Tab after: 18 pt + Indent at: 0 pt, Adjust space between Latin and Asian text, Adjust space between Asian text and numbers, Tab stops: Not at 18 pt

Style Definition: Heading 3: Outline numbered + Level: 3 + Numbering Style: 1, 2, 3, … + Start at: 1 + Alignment: Left + Aligned at: 0 pt + Tab after: 36 pt + Indent at: 0 pt

Style Definition: a2: Indent: Left: 0 pt, Tab stops: Not at 162 pt

Style Definition: a3: Indent: Left: 0 pt, First line: 0 pt, Tab stops: Not at 58.5 pt

Formatted: Font: Cambria

Formatted: Space Before: 0 pt

Formatted: Font: Cambria

Formatted: Font: Cambria, 12 pt, Bold

Formatted: Space After: 11 pt

Formatted: Font: Cambria

Formatted: zzCover, Indent: Left: 0 pt, First line: 0 pt

Formatted: Font: Not Italic, English (United Kingdom)

Formatted: Section start: New page, Numbering: Restart each page, Not Different first page header

Formatted: Font color: Black, English (United States)

Document type: Working draft
Document subtype:
Document stage: (20)
Preparation

Formatted: Adjust space between Latin and Asian text, Adjust space between Asian text and numbers, Tab stops: Not at 31.5 pt

Formatted: Font: 10 pt, Font color: Black, English (United States)

Formatted: Font: 10 pt, Font color: Black, English (United States)

Formatted: Font: 10 pt, Font color: Black, English (United States)

Formatted: Font: 10 pt, Font color: Black, English (United States)

Formatted: Font: 10 pt, Font color: Black, English (United States)

Formatted: Font: 10 pt, Font color: Black, English (United States)

Formatted: Font: 10 pt, Font color: Black, English (United States)

Formatted: Font: 10 pt, Font color: Black, English (United States)

Formatted: Font: 10 pt, Font color: Black, English (United States)

Formatted: Justified, Space After: 0 pt, Adjust space between Latin and Asian text, Adjust space between Asian text and numbers, Tab stops: Not at 31.5 pt

Formatted: Font: 10 pt, Font color: Black

Published in Switzerland.

Contents

FOREWORD 4

INTRODUCTION 5

1 SCOPE 9

2 NORMATIVE REFERENCES 9

3 TERMS AND DEFINITIONS 10

4. CONFORMANCE OF TUPPER TO ISO 21838-1:2020 10

BIBLIOGRAPHY 18

FOREWORD vi

INTRODUCTION 8

1 SCOPE 1

2 NORMATIVE REFERENCES 1

3 TERMS AND DEFINITIONS 2

4 CONFORMANCE OF TUPPER TO ISO 21838-1 3

4.1 Overview 3

4.2 Natural language representation of TUpper 3

4.3 OWL 2 formalization of TUpper 3

4.4 Common Logic axiomatization of TUpper 3

4.4.1 General 3

4.4.2 Modularity 4

Formatted: Font: Cambria

Formatted: zzContents, Right: 0 pt, Space Before: 0 pt, Don't adjust space between Latin and Asian text, Don't adjust space between Asian text and numbers, Tab stops: Not at 476.5 pt

Formatted: Font: Cambria, All caps

4.5 Specification of the purpose of TUpper (in conformance to ISO/IEC 21838-1:2021, 4.4.2) 4
4.6 Conformance of a domain ontology to TUpper (in conformance to ISO/IEC 21838-1:2021, 4.4.3) 5
4.7 Consistency of the CL axiomatization of TUpper (in conformity to ISO/IEC 21838-1:2021, 4.4.4) 5
4.8 Interpretability of the OWL 2 axiomatization of TUpper in the CL axiomatization (in conformity to ISO/IEC 21838-1:2021, 4.4.5) 5
4.9 Demonstration of breadth of coverage of TUpper (in conformance to ISO/IEC 21838-1:2021, 4.4.6) 5
4.9.1 General 5
4.9.2 Space and time 5
4.9.3 Actuality and possibility 6
4.9.4 Classes and types 6
4.9.5 Change over time 6
4.9.6 Parts, wholes, unity and boundaries 6
4.9.7 Space and place 6
4.9.8 Scale and granularity 7
4.9.9 Qualities and other attributes 7
4.9.10 Quantities and mathematical entities 7
4.9.11 Processes and events 7
4.9.12 Constitution 7
4.9.13 Causality 7
4.9.14 Information and reference 7
4.9.15 Artefacts and socially constructed entities 8
4.9.16 Mental entities, imagined entities, fiction, mythology, religion 8
4.10 Documentation of ontology management principles (in conformance to ISO/IEC 21838-1:2021, 4.4.8) 8
BIBLIOGRAPHY 9

Formatted: TOC 1, Right: 0 pt, Space Before: 0 pt, Don't adjust space between Latin and Asian text, Don't adjust space between Asian text and numbers, Tab stops: Not at 31.5 pt

Formatted: Font: 12 pt

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see ~~www.iso.org/directives~~www.iso.org/directives, or ~~www.iec.ch/members_experts/refdocs~~www.iec.ch/members_experts/refdocs).

~~Attention is drawn~~ISO and IEC draw attention to the possibility that ~~some of the elements~~implementation of this document may ~~be~~involve the ~~subject~~use of (a) patent(s). ISO and IEC take no position concerning the evidence, validity or applicability of any claimed patent rights~~.~~ in respect thereof. As of the date of publication of this document, ISO and IEC had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents and https://patents.iec.ch. ISO and IEC shall not be held responsible for identifying any or all such patent rights. ~~Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents) or the IEC list of patent declarations received (see https://patents.iec.ch).~~

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see ~~www.iso.org/iso/foreword.html~~www.iso.org/iso/foreword.html. In the IEC, see ~~www.iec.ch/understanding-standards~~www.iec.ch/understanding-standards.

This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 32, *Data management and interchange*.

A list of all parts in the ISO/IEC 21838 series can be found on the ISO ~~website~~and IEC websites.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at ~~www.iso.org/members.html and www.iec.ch/national-committees~~www.iso.org/members.html and www.iec.ch/national-committees.

Formatted: English (United Kingdom)
Formatted: English (United Kingdom)
Formatted: English (United Kingdom)
Formatted: English (United Kingdom)
Formatted: English (United Kingdom)
Formatted: English (United Kingdom)
Formatted: English (United Kingdom)
Formatted: English (United Kingdom)
Formatted: English (United Kingdom)
Formatted: English (United Kingdom)
Formatted: English (United Kingdom)
Formatted: std_publisher
Formatted: std_docNumber
Formatted: Adjust space between Latin and Asian text, Adjust space between Asian text and numbers
Formatted: Default Paragraph Font
Formatted: English (United Kingdom)
Formatted: English (United Kingdom)

Introduction

TUpper is a top-level ontology (TLO) conforming to ISO/IEC 21838-1:2021. It contains definitions of its terms and relational expressions and formal representations in OWL 2 and in Common Logic (CL).

Top-level ontologies have traditionally arisen from the approach in which concepts that are common across a set of domains can be axiomatized at a general level. The rationale is that reuse across domains is to be supported through specialization of the general concepts from a top-level ontology. Similarly, semantic integration between ontologies is to be achieved through the general concepts they specialize. The TUpper ontology follows an alternative approach (referred to as the sideways approach) to the conventional top-level ontology paradigm. Rather than think of a top-level ontology as a monolithic axiomatization centred on a taxonomy, the sideways approach considers a top-level ontology to be a modular ontology composed of ontologies that cover concepts including those related to time, process, and space, from which any underlying taxonomy can be inferred. Each module within TUpper is a set of axioms from an existing ISO standard. The central claim is that a top-level ontology is an ontology that has a reduction whose modules are all ontologies that satisfy a subset of the requirements for a top-level ontology in ISO/IEC 21838-1:2021. New top-level ontologies can be designed by the union of different ontologies that already exist rather than harmonizing different ontologies.

The TUpper ontology is designed as a top-level ontology that contains modules from the ontologies within existing international standards, and that extends these modules so as to satisfy the criteria for top level ontologies in ISO/IEC 21838-1:2021. The modules of PSL appear in ISO 18629. The modules for mereotopology and location arise from ISO 19107:2019 and ISO 19150-1:2012. Modules related to units of measure arise from ISO 80000.

TUpper-terms, the natural language specification of TUpper, supports human maintenance and use of the ontology, including use in development of conformant domain ontologies.

Tupper-OWL, the OWL 2 formalization of TUpper, enables TUpper to be integrated with other ontologies expressed in OWL and in related languages, and supports the use of OWL automated reasoners.

TUpper-CL, the CL formalization of TUpper, provides the axiomatization of the intended semantics of TUpper.

This document conforms to ISO/IEC 21838-1:2021.

Formatted: std_publisher
Formatted: std_docNumber
Formatted: std_docPartNumber
Formatted: Body Text, Right: 0 pt, Don't adjust space between Latin and Asian text, Don't adjust space between Asian text and numbers, Pattern: Clear, Tab stops: Not at 31.5 pt
Formatted: Body Text, Don't adjust space between Latin and Asian text, Don't adjust space between Asian text and numbers
Formatted: std_publisher
Formatted: std_docNumber
Formatted: std_docPartNumber
Formatted: std_publisher
Formatted: std_docNumber
Formatted: std_publisher
Formatted: std_docNumber
Formatted: std_publisher
Formatted: std_docNumber
Formatted: std_docPartNumber
Formatted: std_publisher
Formatted: std_docNumber
Formatted: Tab stops: Not at 31.5 pt + 355.5 pt
Formatted: Tab stops: Not at 31.5 pt

Information technology — Top-level ontologies (TLO) — Part 4: TUpper

1 Scope

This document describes TUpper as an ontology that is conformant to the requirements specified for top-level ontologies in ISO/IEC 21838-1.

This document describes TUpper as a resource designed to support ontology design, ontology integration, automated reasoning, and semantic integration of heterogeneous information systems.

The following are within the scope of this document:

— definitions of classes and relations in the signature of TUpper;

— axiomatizations of TUpper in OWL 2 and CL;

— documentation of the conformity of TUpper to the requirements specified for top-level ontologies in ISO/IEC 21838-1;

— documentation of the methodology for specifying domain ontologies that conform to TUpper.

The following are outside the scope of this document:

— specification of ontology languages, including the languages RDF, OWL, and CL standardly used in ontology development;

— specification of methods for reasoning with ontologies;

— specification of translators between the notations of ontologies developed in different ontology languages.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. ~~The~~For dated references, only the edition cited applies. For undated references, the latest edition of the referenced ~~documents~~document (including any amendments) applies.

ISO/IEC 21838-1:2021, *Information technology — Top-level ontologies (TLO) — Part 1: Requirements*

Formatted: Numbering: Restart each page
Formatted: std_publisher
Formatted: std_docNumber
Formatted: std_docPartNumber
Formatted: List Continue 1, Tab stops: 19.85 pt, Left + 39.7 pt, Left + 59.55 pt, Left + 79.4 pt, Left + 99.25 pt, Left + 119.05 pt, Left + 138.9 pt, Left + 158.75 pt, Left + 178.6 pt, Left + 198.45 pt, Left
Formatted: std_publisher
Formatted: std_docNumber
Formatted: std_docPartNumber
Formatted: Adjust space between Latin and Asian text, Adjust space between Asian text and numbers
Formatted: Default Paragraph Font
Formatted: std_year

ISO/IEC 24707~~:2018~~, *Information technology- — Common Logic (CL)- — A framework for a family of logic-based ~~language~~languages*

~~ISO/IEC 18629-11:2005, *Industrial automation systems and integration — Process specification language — Part 11: PSL core*~~

~~ISO/IEC 18629-12:2005, *Industrial automation systems and integration — Process specification language — Part 12: Outer core*~~

~~ISO/IEC 18629-13:2006, *Industrial automation systems and integration — Process specification language — Part 13: Core Theories*~~

~~ISO/IEC 19107:2019, *Geographic Information — Spatial Schema*~~

~~ISO/TS 19150-1:2012, *Geographic Information — Ontology — Part 1 : Framework*~~

3 Terms and definitions

For the purposes of this document, the terms and definitions in ISO/IEC 21838-1~~:2021~~ and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at ~~http://www.iso.org/obp~~https://www.iso.org/obp

— IEC Electropedia: available at ~~http://www.electropedia.org/~~https://www.electropedia.org/

3.1
conservative extension
superset of axioms from which no new theorems in the signature of the original logical theory are provable

3.2
consistent extension
supserset of axioms which is a consistent logical theory

3.3
logically synonymous, adj
theories whose sets of models are in a one-to-one correspondence

3.4
module
subset of the axioms in a formal theory that is a *conservative extension* (3.1) of the subset

3.5
reduction

Formatted: Default Paragraph Font

Formatted: TermNum, Don't adjust space between Latin and Asian text, Don't adjust space between Asian text and numbers

Formatted: Font: Bold

Formatted: Term(s), Don't adjust space between Latin and Asian text, Don't adjust space between Asian text and numbers

Formatted: cite_sec

Formatted: Term(s), Don't adjust space between Latin and Asian text, Don't adjust space between Asian text and numbers

