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SNOMED CT Logic Profile Specification

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This document defines the description logic feature set with which SNOMED CT content is described. This specification sets the limits of the description logic constructs used to define the content of the SNOMED CT International Edition.

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1. Introduction

Background

SNOMED CT is a clinical terminology with a comprehensive coverage of wide clinical specialties and requirements. The development and maintenance of SNOMED CT relies on description logics (DL) and its reasoning capabilities. In order to correctly interpret SNOMED CT's concept definitions, it is essential to clearly understand the translation between SNOMED CT's structures and their DL meaning.

Purpose

The purpose of this document is to define the description logic fragment or feature set (analogous to an OWL2 profile https://www.w3.org/TR/owl2-profiles/) with which SNOMED CT content is described.

Scope

This document presents the specification of the set of description logic features and constructs valid for use within SNOMED International. The meaning of SNOMED CT concepts in a SNOMED CT International release is guaranteed to be limited to the features and constructs defined in this specification.

SNOMED CT extensions may choose to include features or constructs not included in this specification. However, any extended set of features must be formally specified and clearly advertised. This document does not specify the feature set of any extension.

This document specifies the set of description logic features available to define content in the International release of SNOMED CT. However, it does not provide specifications of how these features or constructs are represented, distributed, or translated. While these are also important topics, they are out of scope for this document.

Audience

The target audiences of this document includes:

- SNOMED CT National Release Centers;
- SNOMED CT terminology content developers, technical developers;
- SNOMED CT implementers and analysts including developers of EHR information systems.

2. Profile Objectives

There is a natural tension between the desire to use features so content may be more expressive and precise, and the cost and complexity of these features.

The desire to use more expressive features is also not uniform across different content domains, and may vary further between SNOMED CT extensions' more specific requirements.

The cost of introduction of more features in general, and each feature specifically, must be weighed against the need, and the adverse consequences of alternatives and workarounds.

Ultimately this is a trade off made to meet a mixture of requirements and drivers. This specification has been designed to meet the balanced needs of the International Edition of SNOMED CT. As a result it specifies the features included to support the International Edition and most extensions, supporting sufficient expressivity for content while remaining tractable for implementation.

However, it must be acknowledged that extensions may choose to use features that extend beyond the SNOMED CT Logic Profile defined in this document, for which there may be very valid reasons.

This extension is not without consequence. For example, tools designed to be used with the SNOMED CT Logic Profile may not function correctly, and classification times may increase significantly. However these trade-offs may be acceptable within the context of the extension.

The SNOMED CT Logic Profile defined in this document does not seek to limit extensions. However, it does define a reliable profile that implementers can expect the International Edition, and most extensions, to exist within and thereby provides a predictable landscape for tool building and implementation.

3. Logic Profile Specification

The SNOMED CT Logic Profile is a subset of the OWL 2 EL profile https://www.w3.org/TR/owl2-profiles/#OWL_2_EL as specified in the following sections.

For clarity, the profile has been defined in terms of OWL 2 structure and feature naming, and the profile definition has been deliberately borrowed from, and been kept stylistically similar to, the W3C OWL 2 profile definitions.

3.1. Feature Overview

SNOMED CT supports the following types of class restrictions:

- existential quantification to a class expression (ObjectSomeValuesFrom)
- intersection of classes (ObjectIntersectionOf)
- existential quantification to a literal (DataHasValue)

SNOMED CT supports the following axioms, all of which are restricted to the allowed set of class expressions:

- class inclusion (SubClassOf)
- class equivalence (EquivalentClasses)
- object property inclusion (SubObjectPropertyOf) with or without property chains, and data property inclusion (SubDataPropertyOf)
- transitive object properties (TransitiveObjectProperty)
- reflexive object properties (ReflexiveObjectProperty)

The following constructs are not supported in SNOMED CT:

- assertions (SameIndividual , DifferentIndividuals , ClassAssertion , ObjectPropertyAssertion , DataPropertyAssertion , NegativeObjectPropertyAssertion , and NegativeDataPropertyAssertion)
- functional data properties (FunctionalDataProperty)
- keys (HasKey)
- domain restrictions (ObjectPropertyDomain and DataPropertyDomain)
- range restrictions (ObjectPropertyRange and DataPropertyRange)
- intersection of data ranges (DataIntersectionOf)
- existential quantification to a data range (DataSomeValuesFrom)
- existential quantification to an individual (ObjectHasValue)
- self-restriction (ObjectHasSelf)
- enumerations involving a single individual (ObjectOneOf) or a single literal (DataOneOf)
- universal quantification to a class expression (ObjectAllValuesFrom) or a data range (DataAllValuesFrom)
- cardinality restrictions (ObjectMaxCardinality , ObjectMinCardinality , ObjectExactCardinality , DataMaxCardinality , DataMinCardinality , and DataExactCardinality)
- disjunction (ObjectUnionOf , DisjointUnion , and DataUnionOf)
- class negation (ObjectComplementOf)
- class disjointness (DisjointClasses)
- enumerations involving more than one individual (ObjectOneOf and DataOneOf)
- disjoint properties (DisjointObjectProperties and DisjointDataProperties)
- property equivalence (EquivalentObjectProperties and EquivalentDataProperties)
- irreflexive object properties (IrreflexiveObjectProperty)
- inverse object properties (InverseObjectProperties)
- functional and inverse-functional object properties (FunctionalObjectProperty and InverseFunctionalObjectProperty)
- symmetric object properties (SymmetricObjectProperty)
- asymmetric object properties (AsymmetricObjectProperty)

Rationale for exclusions

There are a number of notable exclusions from the SNOMED CT Logic Profile, which are features often desired for definition of content. These have been excluded due to their additional complexity and/or impact on reasoning times with current hardware and algorithms, outweighing the benefit they provide.

Largely these notably excluded features are:

- universal quantification to a class expression (ObjectAllValuesFrom)
- disjunction (ObjectUnionOf , DisjointUnion , and DataUnionOf)
- class negation (ObjectComplementOf)

The primary motivation for excluding these features and remaining within the OWL 2 EL profile is to ensure classifiers can reason over SNOMED CT content and expressions in a reasonable timeframe. This computational time has implications not just for computing inferred forms for release publication, but also for calculating subsumption relationships for expressions in implementations, particularly affecting runtime expression subsumption.

Therefore while some of the features are desirable for content modelling, moving to OWL 2 DL incurs too high a cost to implementation of SNOMED CT to be supportable at this time. If these features become reasonably practical to add in future (e.g. due to advancements in reasoner technologies) then they may be added. Until that time, modelling patterns must be devised to address the content and use cases that would benefit from these features to work around their absence.

All OWL 2 DL features not included in OWL 2 EL are excluded from the SNOMED CT Logic Profile. Additionally, the following features which are in the OWL 2 EL profile are not included in the SNOMED CT Logic Profile:

- domain and range constraints are not supported in the SNOMED CT Logic Profile as they are supported via the SNOMED CT Machine Readable Concept Model rather than in the Description Logic constructs
- individuals are not supported in SNOMED CT due to a lack of overall utility in SNOMED CT's context
- support exists for DataHasValue; however, usage is restricted to prohibit ranges

3.2. Profile Specification

Entities

Entities in the SNOMED CT Logic Profile are limited to the following entities as defined in the OWL 2 Specification section 5 Entities, Literals and Anonymous Individuals :

- Class
- ObjectProperty
- DataProperty
- Datatype
- Literal
- AnnotationProperty

Predefined classes and properties in OWL 2 are supported. SNOMED CT content will not have direct reference to them because they are implicitly presented in every OWL 2 Ontology.

The SNOMED CT Logic Profile supports the following datatypes:

- xsd:decimal
- xsd:integer
- xsd:string
- xsd:dateTime

This is a selected subset of those datatypes supported by OWL 2 EL to simplify tooling implementation by limiting possible variations to a compact but useful set.

The following entities, literals, and individuals are not supported

- DataRange
- Individual
- NamedIndividual
- AnonymousIndividual

Property Expressions

Inverse properties are not supported in the SNOMED Logic Profile, so object property expressions are restricted to named properties. Data property expressions are defined in the same way as in the OWL 2 structural specification.

ObjectPropertyExpression := ObjectProperty

Class Expressions

In order to allow for efficient reasoning, the SNOMED CT Logic Profile restricts the set of supported class expressions to ObjectIntersectionOf, ObjectSomeValuesFrom, and DataHasValue.

ClassExpression :=

Class | ObjectIntersectionOf | ObjectSomeValuesFrom | DataHasValue

Data Ranges

A data range expression is restricted in the SNOMED CT Logic Profile to single data values, ranges and enumerations are not permitted.

DataRange := Datatype

Axioms

The class axioms of the SNOMED CT Logic Profile are the same as in the OWL 2 structural specification, with the exception that DisjointUnion is disallowed. Different class axioms are defined in the same way as in the OWL 2 structural specification, with the difference that they use the new definition of ClassExpression.

ClassAxiom := SubClassOf | EquivalentClasses | DisjointClasses

The SNOMED CT Logic Profile supports the following object property axioms, which are defined in the same way as in the OWL 2 structural specification, with the difference that they use the new definition of ObjectPropertyExpression.

ObjectPropertyAxiom :=

EquivalentObjectProperties | SubObjectPropertyOf |

ReflexiveObjectProperty | TransitiveObjectProperty

The SNOMED CT Logic Profile does not support ObjectPropertyDomain and ObjectPropertyRange as they are supported via the SNOMED CT Machine Readable Concept Model.

The SNOMED CT Logic Profile supports the following axioms about data properties:

DataPropertyAxiom :=

SubDataPropertyOf | EquivalentDataProperties | FunctionalDataProperty

The SNOMED CT Logic Profile does not support the following axioms about data properties:

- DisjointDataProperties
- DataPropertyDomain and DataPropertyRange which are supported via the SNOMED CT Machine Readable Concept Model

The assertions in the SNOMED CT Logic Profile, as well as all other axioms, are the same as in the OWL 2 structural specification, with the difference that class object property expressions are restricted as defined in the previous sections.

Global Restrictions

The SNOMED CT Logic Profile does not apply the additional global restriction in section 2.2.6 Global Restrictions of the OWL 2 EL profile. The condition this section applies is only relevant to ObjectPropertyRange which the SNOMED CT Logic Profile does not support.