

Ontology for Smart City and Smart City System & Standards



IEC SyC Smart Cities – Virtual workshop

Wednesday, 30 September 2020 11:00 – 14:00 UTC

Terminology or Ontology? A matter of concept



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ISO/IEC JTC 1 INFORMATION TECHNOLOGY









JTC 1 is the standards development environment where experts come together to develop worldwide Information and Communication Technology (ICT) standards for business and consumer applications.







STRATEGIC BUSIN	SMB/6817/R	
IEC/TC OR SC: SyCSmart Cities	SECRETARIAT:	DATE: 2019-07-26

Strategic ObjectivesTo propose using the modern ontological tools, techniques to express the
Smart Cities concepts and relationships between them in an explicit, formal,
machine-readable and machine-executable form.





Scope https://jtc1info.org/sd-2-history/jtc1-working-groups/wg-11/

Develop foundational standards for the use of ICT in Smart Cities – including the Smart City ICT Reference Framework and an **Upper Level Ontology for Smart Cities** – for guiding Smart Cities efforts throughout JTC 1 upon which other standards can be developed.



TECHNICAL COMMITTEES

dards Abo

Standardization of principles and methods related to terminology, terminology policies and knowledge organization.



ISO/TC 37 Language and terminology

Scope Standardization of descriptions, resources, technologies and services related to terminology, translation, interpreting and other language-based activities in the multilingual information society.

Standardization of principles and methods related to terminology, terminology policies and knowledge organization.

ISO/TC 37/SC 1	Principles and methods
ISO/TC 37/SC 2	Terminology workflow and language coding
ISO/TC 37/SC 3	Management of terminology resources
ISO/TC 37/SC 4	Language resource management
ISO/TC 37/SC 5	Translation, interpreting and related technology

ISO 1087:2019 Terminology work and terminology science — Vocabulary

This document establishes basic terms and definitions for terminology work and terminology science. **It does not include terms and definitions that are specific to computer applications in terminology work**.

ISO 704:2009 Terminology work — Principles and methods

ISO 704:2009 establishes the basic principles and methods for preparing and compiling terminologies both inside and outside the framework of standardization, and describes the links between objects, concepts, and their terminological representations.

The terminology work dealt with in this International Standard is concerned with <u>terminology</u> <u>used for unambiguous communication in natural, human language</u>. The goal of terminology work as described in this International Standard is, thus, a clarification and standardization of concepts and terminology for <u>communication between humans</u>. Terminology work may be used as input for information modelling and data modelling, but <u>this International Standard</u> <u>does not cover the relation with these fields</u>.



Ontology is becoming a key subject in the world of smart city standards for two reasons:

- One of the most important requirements of standards is that their language needs to be clear and unambiguous, so that there is no room for **users** to misunderstand the guidance provided. Ontology is a discipline that helps us do this.
- It is also vital when **data** is being shared between city departments and different cities that the data is described using a common ontology



https://shop.bsigroup.com/upload/PASs/Free-Download/PAS180.pdf PAS 180:2014



BSI Standards Publication

Smart cities – Vocabulary



"in a machine-readable form" ?



3 Enabling concepts

3.1 Smart city systems

3.1.1 access rights

permission for a subject to access a particular **object (3.4.20)** for a specific type of operation

[ISO/IEC 2382-8:1998, 08.04.05]

EXAMPLE Requesting information from an **object (3.4.20)**, changing values of variables in it or modifying its state, e.g. read-access to a shared variable; permission to turn on, or off (i.e. execute certain operations).

NOTE Where more than one service or **application** (3.1.5) requires access to an **object** (3.4.20) for one or more specific purposes, then levels of access must be defined, including the definition of the primary owner of the **access rights** (3.1.11) [possibly the owner of the **object** (3.4.20)].

3.1.2 action limits

control limits between which the statistic under consideration lies with a very high probability when the process is under statistical control

[ISO 3534-2:2006, 2.4.4]

3.1.3 adaptive system

system which becomes adaptive and learns its own behaviour, becoming a "self-learning system"



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In a machine-readable form?



3.1.62 smart city



effective integration of physical, digital and human systems in the built environment to deliver a sustainable, prosperous and inclusive future for its citizens

3.31 smart city infrastructure

IEC 60050-831

ISO 37122:2019

community infrastructure with enhanced technological performance that is designed, operated, and maintained to contributed to sustainable development and resilience of the community

3.1 Smart city



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A smart city is one that increases the pace at which it provides social, economic, and environmental sustainability outcomes. Smart cities respond to challenges such as climate change, rapid population growth, and political and economic instability by fundamentally improving how they engage society, apply collaborative leadership methods, work across disciplines and city systems, and use data information and modern technologies to deliver better services and quality of life to those in the city (residents, businesses, visitors), now and for the foreseeable future, without unfair disadvantage of the natural environment.

In a human-readable form?

In a human-understandable form?

Enterprise Integration Laboratory Ontologies Library

Enterprise Integration Lab, University of Toronto Contact: Mark S. Fox, msf@eil.utoronto.ca Updated: 27 January 2020

http://ontology.eil.utoronto.ca/#icity

Global Cities Indicator Ontologies Plus ISO 37120 Indicator Definitions

- ISO37120 Indicator Identifier Ontology
 - Reference: ISO37120.
 - Documentation: Not Available
 - Ontology: <u>http://ontology.eil.utoronto.ca/ISO37120.owl</u>
- Global City Indicator Foundation Ontology
 - Reference: Fox, M.S., (2013), <u>A Foundation Ontology for Global City Indicators</u>", Working Paper, Enterprise Integration Lab, University of Toronto, First published: June 2013; Revised: 13 October 2017.
 - Documentation: http://ontology.eil.utoronto.ca/GCI/Foundation/GCI-Foundation.html
 - Ontology version 1: http://ontology.eil.utoronto.ca/GCI/Foundation/GCI-Foundation.owl
 - Ontology version 2: http://ontology.eil.utoronto.ca/GCI/Foundation/GCI-Foundation-v2.owl
- Global City Indicator Education Ontology
 - Reference: Fox, M.S., (2014), "<u>An Education Ontology for Global City Indicators (ISO 37120)</u>", Working Paper, Enterprise Integration Lab, University of Toronto. Revised: 16 May 2015.
 - Documentation: http://ontology.eil.utoronto.ca/GCI/Education/GCI-Education.html
 - Ontology: http://ontology.eil.utoronto.ca/GCI/Education/GCI-Education.owl
 - ISO 37120 Education Theme Indicators Definitions: <u>http://ontology.eil.utoronto.ca/GCI/ISO37120/Education.owl</u>

• Global City Indicator Energy Ontologies

 Reference: Komisar, K., and Fox, M.S., (2017), "<u>An Energy Ontology for Global City Indicators (ISO 37120)</u>", Working Paper, Enterprise Integration Lab, University of Toronto. 17 May 2017.

- Ontologies:
 - http://ontology.eil.utoronto.ca/GCI/Energy/GCI-Service.owl
 - http://ontology.eil.utoronto.ca/GCI/Energy/GCI-BuildingOccupancy.owl
- ISO 37120 ENergy Theme Indicators Definitions: http://ontology.eil.utoronto.ca/GCI/ISO37120/Energy.owl
- Global City Indicator Environment Ontology
 - Reference: Dahleh, D., and Fox, M.S., (2016), "<u>An Environment Ontology for Global City Indicators (ISO 37120)</u>", Working Paper, Enterprise Integration Lab. University of Toronto, 17 September 2016; Updated: 30 September 2016.
 - Ontologies:
 - http://ontology.eil.utoronto.ca/GCI/Environment/Pollution.owl
 - http://ontology.eil.utoronto.ca/GCI/Environment/Species.owl
 - http://ontology.eil.utoronto.ca/GCI/Environment/Sensors.owl
 - ISO 37120 Environment Theme Indicators Definitions: http://ontology.eil.utoronto.ca/GCI/ISO37120/Environment.owl

In an human-readable form?

In an human-understandable form?



http://ontology.eil.utoronto.ca/tove/activity.owl

Class name versus Label (Term)?

Definition in Natural Language *versus* **Definition in Formal Language?**



Is everything in the name?

		N	alchigar S and Fox M S, 2017, "Achieving Interoperability of Smart City
🍕 311RO (http://ontology.eil.utoronto.ca/311RO.owl) : [http://ontology.eil.utoronto.ca/311RO.owl]			ata: An Analysis of 311 Data". Journal of Smart Cities, vol.3(1): 1-XX.
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< > 311RO (http://ontology.eil.utoronto.ca/311RO	.owl)		Search
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What do we need?



Definition of terms in natural language

⇔ term

⇒ term definition



A term is a verbal designation of a concept





Definition of concepts in a computer-readable form

⇒ concept



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 \Rightarrow concept definition

Experts



- Don't define concepts as restrictions of properties
- Aristotelian definition

Species ::= Genus + Differentia(e)

Formal definitions are required:

- Objective
- Shareable
- Computational



"As the group that developed Protégé, the most widely used ontology editor, we are keenly aware of how difficult the users perceive this task to be."

Horridge M., Tudorache T., Vendetti J., Nyulas C., Musen M., Noy N. (2013). "Simplified OWL ontology editing for the web: is WebProtégé enough?", The Semantic Web - ISWC 2013

Terminology versus Ontology



Cultural Heritage



The **Tao Ci** Project aims to construct the ontoterminology of the ceramic vases of the Ming and Qing dynasties.





http://www.dh.ketrc.com/



http://o4dh.com/lekythos



The **Lekythos** project aims to define the ontoterminology of the Ancient Greek Vases.



http://o4dh.com/



Christophe Roche - <u>http://christophe-roche.ir/</u> - (<u>CC B1-5A 4.0</u>) (CD C)

Class versus **Concept**

W3C

Class

Set of individuals

Classes are defined using formal descriptions that state precisely the requirements for membership of the class.

"The key idea is that a class of individuals is described or defined by the relationships that these individuals participate in."

> A Practical Guide To Building OWL Ontologies Using Protege 4 and CO-ODE Tools Edition 1.3 - Matthew Horridge



Class versus **Concept**



Class versus **Concept**

Concept

ISO

- unit of knowledge created by a unique combination of characteristics
- essential characteristic characteristic which is indispensable to understanding a concept

Axes of analysis:

- Function= {/for mixing wine and water/, /for storing and transport/, /for perfume/}
- Mouth = {/with narrow mouth/, /with open mouth/}
- Neck = {/with neck/, /without neck/}
- Handles = {/with column-like handles/, /with volute-like handles/, /with upward curling handles/} Location on the body = {/placed high on the body/, /placed low on the body/} etc.



"bell krater" = Krater without neck with upward curling handles placed high on the body 21

Essential Characteristics in Protégé?

Axes of analysis:

Function= {/for mixing wine and water/, /for storing and transport/, /for perfume/}

Mouth = {/with narrow mouth/, /with open mouth/}

Neck = {/with neck/, /without neck/}

Handles = {/with column-like handles/, /with volute-like handles/, /with upward curling handles/} Location on the body = {/placed high on the body/, /placed low on the body/} ______ etc.



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ontoTerminology EDItor: a Tooled Method

http://ontoterminology.com/



ontoTerminology EDItor: a Tooled Method



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Тес	di Onto-Dictionary on "Ontotermino	ology of Vases" (© Christophe Roche
Date: 28 août 2020 - Time: 18:06:07 - search: amphora bell krater calyx krater column krater hydria krater lekythos vase volute krater	 Version: 2.1 - <u>www.ontoterminology.com/tedi</u> bell krater Definition: Krater without neck, with upward curling handles place Status: preferred Source: Expert Note(s): The latest of the four krater-types, it first occurs in the early fifth century, ar perhaps originating in wood. It has small horizontal upturned handles just over have lugs for handles. Over the course of the fifth and fourth centuries, the shit Accessible online: https://www.beazley.ox.ac.uk/tools/pottery/shapes/bell.htm Equivalent(s):	ed high on the body. Ind is not found decorated in black-figur r halfway up the body. Some do not h ape becomes slimmer." Classical Art (2020 05 08) with upward curling handles upwar handle(s)/, /for mixing wine with wa >,	rre. It is named for its bell-like shape, ave a foot, and earlier examples may Research Centre, University of Oxford. d curling handles placed high on the ater/, /without neck/, /with upward	
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Conclusion

Issues:



Definition of terms in natural language



W3C

Definition of concepts in a computer-readable form

 Needs:
 ⇒ Theory of Term

 ⇒ Theory of Concept
 Expert's

 ⇒ Methodology
 >

Expert's way of thinking

