Ontology engineering

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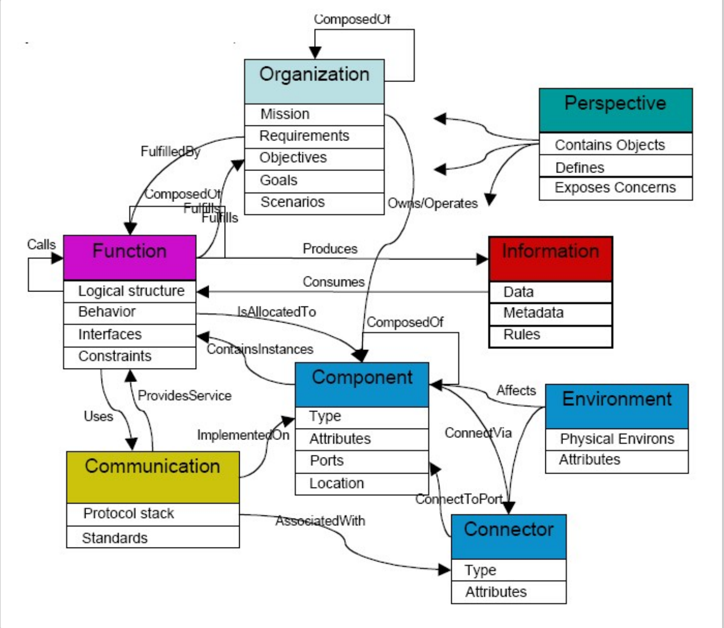
Ontology engineering in computer science and information science is a field which studies the methods and methodologies for building ontologies: formal representations of a set of concepts within a domain and the relationships between those concepts. A large-scale representation of abstract concepts such as actions, time, physical objects and beliefs would be an example of ontological engineering.[2]



Example of a constructed MBED Top Level Ontology based on the Nominal set of views.[1]

Contents

Overview

> [Ontology engineering] aims at making explicit the knowledge contained within software applications, and within enterprises and business procedures for a particular domain. Ontology engineering offers a direction towards solving the inter-operability problems brought about by semantic obstacles, i.e. the obstacles related to the definitions of business terms and software classes. Ontology engineering is a set of tasks related to the development of ontologies for a particular domain.
>
> —Line Pouchard, Nenad Ivezic and Craig Schlenoff, *Ontology Engineering for Distributed Collaboration in Manufacturing*[3]

Ontologies provide a common vocabulary of an area and define, with different levels of formality, the meaning of the terms and the relationships between them. During the last decade, increasing attention has been focused on ontologies. Ontologies are now widely used in knowledge engineering, artificial intelligence and computer science; in applications related to areas such as knowledge management, natural language processing, e-commerce, intelligent information integration, bio-informatics, education; and in new emerging fields like the semantic web. Ontological engineering is a new field of study concerning the ontology development process, the ontology life cycle, the methods and methodologies for building ontologies,[4][5] and the tool suites and languages that support them.

Ontology languages

An ontology language is a formal language used to encode the ontology. There are a number of such languages for ontologies, both proprietary and standards-based:

- Common logic is ISO standard 24707, a specification for a family of ontology languages that can be accurately translated into each other.
- The Cyc project has its own ontology language called CycL, based on first-order predicate calculus with some higher-order extensions.
- The Gellish language includes rules for its own extension and thus integrates an ontology with an ontology language.
- IDEF5 is a software engineering method to develop and maintain usable, accurate, domain ontologies.
- KIF is a syntax for first-order logic that is based on S-expressions.
- Rule Interchange Format (RIF) and F-Logic combine ontologies and rules.
- OWL is a language for making ontological statements, developed as a follow-on from RDF and RDFS, as well as earlier ontology language projects including OIL, DAML and DAML+OIL. OWL is intended to be used over the World Wide Web, and all its elements (classes, properties and individuals) are defined as RDF resources, and identified by URIs.
- XBRL (Extensible Business Reporting Language) is a syntax for expressing business semantics.
- OntoUML is a well-founded language for specifying reference ontologies.

Ontology engineering in life sciences

Life sciences is flourishing with ontologies that biologists use to make sense of their experiments.[6] For inferring correct conclusions from experiments, ontologies have to be structured optimally against the knowledge base they represent. The structure of an ontology needs to be changed continuously so that it is an accurate representation of the underlying domain.

Recently, an automated method was introduced for engineering ontologies in life sciences such as Gene Ontology (GO),[7] one of the most successful and widely used biomedical ontology.[8] Based on information theory, it restructures ontologies so that the levels represent the desired specificity of the concepts. Similar information theoretic approaches have also been used for optimal partition of Gene Ontology.[9] Given the mathematical nature of such engineering algorithms, these optimizations can be automated to produce a principled and scalable architecture to restructure ontologies such as GO.

Open Biomedical Ontologies (OBO), a 2006 initiative of the U.S. National Center for Biomedical Ontology, that provides a common 'foundry' for various ontology initiatives, amongst which are:

- The Generic Model Organism Project (GMOD)

- Gene Ontology Consortium
- Sequence Ontology
- Ontology Lookup Service
- The Plant Ontology Consortium
- Standards and Ontologies for Functional Genomics

and more

Tools for ontology engineering

- DOGMA
- DogmaModeler
- KAON
- OntoClean
- OnToContent
- HOZO
- Protégé (software)
- OLED (OntoUML Editor) (https://code.google.com/p/ontouml-lightweight-editor/)
- OntoCAT (http://www.ontocat.org)[10][11]
- Fluent Editor (software)

See also

- Ontology
- Ontology learning
- Ontology double articulation
- Ontology modularization
- Semantic decision table

References

1. Peter Shames, Joseph Skipper. "Toward a Framework for Modeling Space Systems Architectures" (http://trs-new.jpl.nasa.gov/dspace/bitstream/2014/39851/1/06-0876.pdf). NASA, JPL.
2. http://ontology.buffalo.edu/bfo/BeyondConcepts.pdf
3. Line Pouchard, Nenad Ivezic and Craig Schlenoff (2000) "Ontology Engineering for Distributed Collaboration in Manufacturing" (http://www.mel.nist.gov/msidlibrary/doc/AISfinal2.pdf). In *Proceedings of the AIS2000 conference*, March 2000.
4. Asunción Gómez-Pérez, Mariano Fernández-López, Oscar Corcho (2004). *Ontological Engineering: With Examples from the Areas of Knowledge Management, E-commerce and the Semantic Web*. Springer, 2004.
5. De Nicola, A; Missikoff, M; Navigli, R (2009). "A software engineering approach to ontology building" (http://www.dsi.uniroma1.it/~navigli/pubs/De_Nicola_Missikoff_Navigli_2009.pdf) (PDF). *Information Systems* **34** (2): 258. doi:10.1016/j.is.2008.07.002 (https://dx.doi.org/10.1016%2Fj.is.2008.07.002).

6. Malone, J; Holloway, E; Adamusiak, T; Kapushesky, M; Zheng, J; Kolesnikov, N; Zhukova, A; Brazma, A; Parkinson, H (2010). "Modeling sample variables with an Experimental Factor Ontology" (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2853691). *Bioinformatics* **26** (8): 1112–1118. doi:10.1093/bioinformatics/btq099 (https://dx.doi.org/10.1093%2Fbioinformatics%2Fbtq099). PMC 2853691 (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2853691). PMID 20200009 (https://www.ncbi.nlm.nih.gov/pubmed/20200009).
7. Alterovitz, G; Xiang, M; Hill, DP; Lomax, J; Liu, J; Cherkassky, M; Dreyfuss, J; Mungall, C et al. (2010). "Ontology engineering". *Nature Biotechnology* **28** (2): 128–30. doi:10.1038/nbt0210-128 (https://dx.doi.org/10.1038%2Fnbt0210-128). PMID 20139945 (https://www.ncbi.nlm.nih.gov/pubmed/20139945).
8. Botstein, David; Cherry, J. Michael; Ashburner, Michael; Ball, Catherine A.; Blake, Judith A.; Butler, Heather; Davis, Allan P.; Dolinski, Kara et al. (2000). "Gene ontology: Tool for the unification of biology. The Gene Ontology Consortium" (http://www.geneontology.org/GO_nature_genetics_2000.pdf) (PDF). *Nature Genetics* **25** (1): 25–9. doi:10.1038/75556 (https://dx.doi.org/10.1038%2F75556). PMC 3037419 (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3037419). PMID 10802651 (https://www.ncbi.nlm.nih.gov/pubmed/10802651).
9. Alterovitz, G.; Xiang, M.; Mohan, M.; Ramoni, M. F. (2007). "GO PaD: The Gene Ontology Partition Database" (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1669720). *Nucleic Acids Research* **35** (Database issue): D322–7. doi:10.1093/nar/gkl799 (https://dx.doi.org/10.1093%2Fnar%2Fgkl799). PMC 1669720 (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1669720). PMID 17098937 (https://www.ncbi.nlm.nih.gov/pubmed/17098937).
10. Adamusiak, T; Burdett, T; Kurbatova, N; Joeri van der Velde, K; Abeygunawardena, N; Antonakaki, D; Kapushesky, M; Parkinson, H; Swertz, MA (May 29, 2011). "OntoCAT--simple ontology search and integration in Java, R and REST/JavaScript" (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3129328). *BMC Bioinformatics* **12**: 218. doi:10.1186/1471-2105-12-218 (https://dx.doi.org/10.1186%2F1471-2105-12-218). PMC 3129328 (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3129328). PMID 21619703 (https://www.ncbi.nlm.nih.gov/pubmed/21619703).
11. Kurbatova, N; Adamusiak, T; Kurnosov, P; Swertz, MA; Kapushesky, M (Sep 1, 2011). "ontoCAT: an R package for ontology traversal and search". *Bioinformatics (Oxford, England)* **27** (17): 2468–70. doi:10.1093/bioinformatics/btr375 (https://dx.doi.org/10.1093%2Fbioinformatics%2Fbtr375). PMID 21697126 (https://www.ncbi.nlm.nih.gov/pubmed/21697126).

Further reading

- John Davies (Ed.) (2006). *Larger ImageSemantic Web Technologies: Trends and Research in Ontology-based Systems*. Wiley. ISBN 978-0-470-02596-3
- Asunción Gómez-Pérez, Mariano Fernández-López, Oscar Corcho (2004). *Ontological Engineering: With Examples from the Areas of Knowledge Management, E-commerce and the Semantic Web*. Springer, 2004.
- Jarrar, Mustafa (2006). "Proceedings of the 15th international conference on World Wide Web - WWW '06" (http://www.jarrar.info/publications/J06.pdf.htm) (PDF). p. 497. doi:10.1145/1135777.1135850 (https://dx.doi.org/10.1145%2F1135777.1135850). ISBN 1-59593-323-9. `|chapter=` ignored (help)
- Mustafa Jarrar and Robert Meersman (2008). "Ontology Engineering -The DOGMA Approach" (http://www.jarrar.info/publications/JM08.pdf.htm). Book Chapter (Chapter 3). In Advances in Web Semantics I. Volume LNCS 4891, Springer.
- Riichiro Mizoguchi (2004). "Tutorial on ontological engineering: part 3: Advanced course of ontological engineering" (http://www.ei.sanken.osaka-u.ac.jp/pub/miz/Part3V3.pdf). In: *New Generation Computing*. Ohmsha & Springer-Verlag, 22(2):198-220.
- Elena Paslaru Bontas Simperl and Christoph Tempich (2006). "Ontology Engineering: A Reality Check (http://ontocom.ag-nbi.de/docs/odbase2006.pdf)"
- Devedzić, Vladan (2002). "Understanding ontological engineering". *Communications of the ACM* **45** (4): 136. doi:10.1145/505248.506002 (https://dx.doi.org

/10.1145%2F505248.506002).

External links

- Ontopia.net: Metadata? Thesauri? Taxonomies? Topic Maps! Making Sense of it All (http://www.ontopia.net/topicmaps/materials/tm-vs-thesauri.html), by Lars Marius Garshol, 20004.
- OntologyEngineering.org: Ontology Engineering With Diagrams (http://www.ontologyengineering.org)

Categories: Knowledge engineering | Technical communication | Information science | Semantic Web | Ontology (information science) | Artificial intelligence | Bioinformatics

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