

Unified Foundational Ontology

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Outline

- 1 Unified Foundational Ontology
 - Introduction
 - UFO Modules
 - Categorization of Object Types



Idea

- We will use Unified Foundation Ontology (UFO) as main upper level ontology to guide development of domain level ontology and consequently application ontologies.
- Theoretical background behind the UFO will help us to validate our design decisions during the ontology development.



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Unified Foundational Ontology



Introduction

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What is Unified Foundational Ontology (UFO) ?

- a foundational ontology developed by Giancarlo Guizzardi et al.
- a descriptive ontology representing universals and particulars, endurants and perdurants
- based on theories from Formal Ontology, Philosophical Logics, Philosophy of Language, Linguistics and Cognitive Psychology
- incorporates ideas from GFO, DOLCE and the Ontology of Universals underlying OntoClean

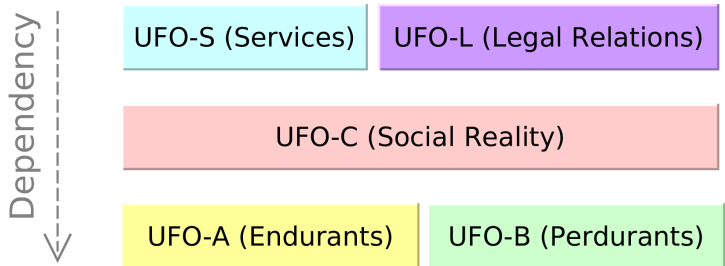


UFO Modules

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 - Categorization of Object Types



UFO Core Modules Structure



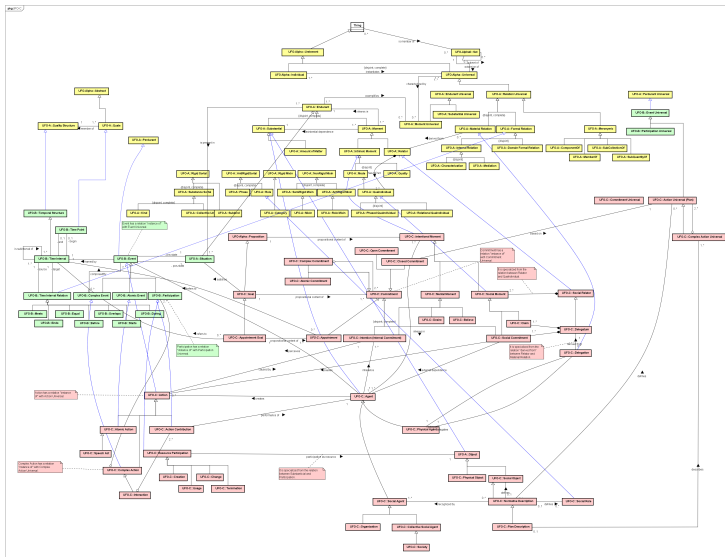
UFO Core Modules Overview¹

- **UFO-A** – an ontology of *endurants* dealing with aspects of structural conceptual modeling such types and taxonomic structures, part-whole relations, particularized intrinsic properties, attributes and attribute value spaces, particularized relational properties and relations, roles[3].
- **UFO-B** – an ontology of *perdurants* (*events, processes*) including perdurant mereology, temporal ordering of perdurants, object participation in perdurants, causation, change and the connection between perdurants and endurants via dispositions [6].
- **UFO-C** – an ontology of *intentional and social entities* addressing notions such as beliefs, desires, intentions, goals, actions, commitments and claims, social roles and social particularized relational complexes (social relators) [4].
- **UFO-S** – an ontology for *commitment-based services* [7].
- **UFO-L** – an ontology representing *legal domain* [2].

¹For detailed overview see [4, 5]



Relations within Core Modules of UFO



Relations among concepts of *UFO-A*, *UFO-B*, and *UFO-C* modules taken from <http://ontouml.org>.



Categorization of Object Types

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Ontological Meta-properties of Object Types

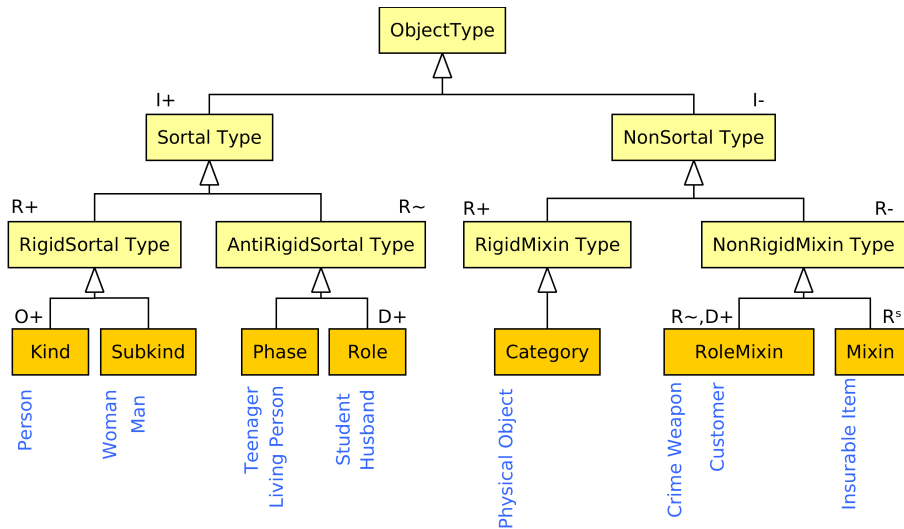
Let \mathbf{T} be an object type².

- Identity
 - $\mathbf{I}^+(\mathbf{T})$ – carries identity
 - $\mathbf{O}^+(\mathbf{T})$ – owns (supply) identity
- Rigidity
 - $\mathbf{R}^+(\mathbf{T}) = \Box(\forall x T(x) \rightarrow \Box(T(x)))$ (Rigid)
 - $\mathbf{R}^-(\mathbf{T}) = \neg\mathbf{R}^+(\mathbf{T}) = \Diamond(\exists x T(x) \wedge \Diamond\neg T(x))$ (Non-Rigid)
 - $\mathbf{R}^\sim(\mathbf{T}) = \Box(\forall x T(x) \rightarrow \Diamond(\neg T(x)))$ (Anti-Rigid)
 - $\mathbf{R}^s(\mathbf{T}) = \mathbf{R}^-(\mathbf{T}) \wedge \neg\mathbf{R}^\sim(\mathbf{T})$ (Semi-Rigid)
- Relational Dependence
 - $\mathbf{D}^+(\mathbf{T}, \mathbf{T}', \mathbf{R}) =_{def} \Box(\forall x T(x) \rightarrow \exists y T'(y) \wedge R(x, y))$

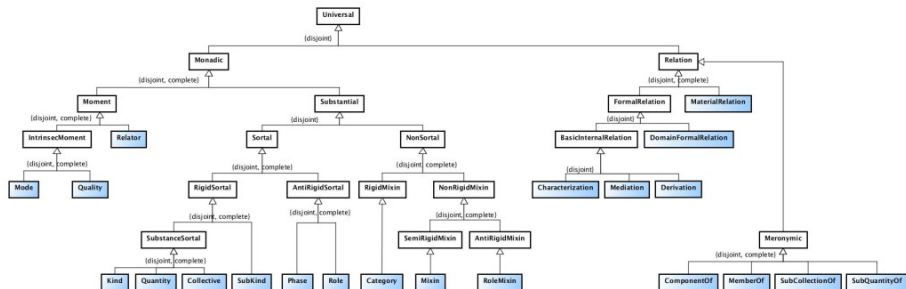
²Might be also referred as “Substantial”.



Categories of Object Types



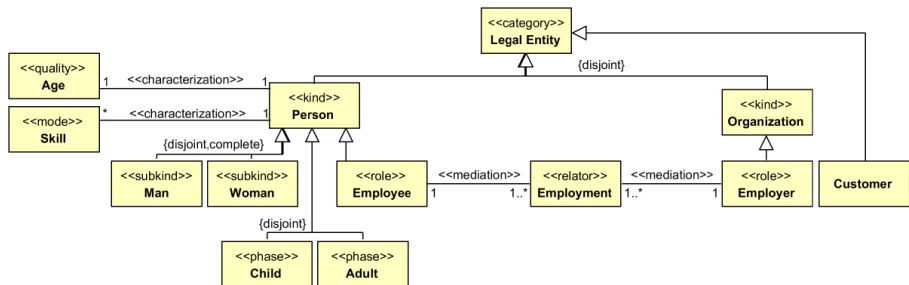
Categories of All Universals



Categorization of all universals taken from <http://ontouml.org>.



An Example



An example of UFO based model in OntoUML taken from [1].



Related resources

- UFO represented in OWL2 ontology –
<http://onto.fel.cvut.cz/ontologies/ufo>
- OntoUML community portal –
<https://ontouml.org/>
- Menthor Editor (an OntoUML editor) –
<http://www.menthor.net/>
- Guizzardi's course materials –
<http://guizzardi.panrepa.org/>



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References



- [1] Victorio A Carvalho et al. “Multi-level ontology-based conceptual modeling”. In: *Data & Knowledge Engineering* (2017).
- [2] Cristine Griffo, João Paulo A Almeida, and Giancarlo Guizzardi. “Towards a Legal Core Ontology based on Alexy’s Theory of Fundamental Rights”. In: *MWAIL, ICAIL 2015* (2015).
- [3] Giancarlo Guizzardi. *Ontological foundations for structural conceptual models*. CTIT, Centre for Telematics and Information Technology, 2005.
- [4] Giancarlo Guizzardi, Ricardo de Almeida Falbo, and Renata SS Guizzardi. “Grounding Software Domain Ontologies in the Unified Foundational Ontology (UFO): The case of the ODE Software Process Ontology.”. In: *CibSE*. 2008, pp. 127–140.
- [5] Giancarlo Guizzardi et al. “Towards ontological foundations for conceptual modeling: the unified foundational ontology (UFO) story”. In: *Applied ontology* 10.3-4 (2015), pp. 259–271.



- [6] Giancarlo Guizzardi et al. “Towards ontological foundations for the conceptual modeling of events”. In: *International Conference on Conceptual Modeling*. Springer. 2013, pp. 327–341.
- [7] Julio Cesar Nardi et al. “Towards a commitment-based reference ontology for services”. In: *Enterprise Distributed Object Computing Conference (EDOC), 2013 17th IEEE International*. IEEE. 2013, pp. 175–184.

