

# 1 Managing Semantic Data

## 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.

## 1.1 Unified Foundational Ontology

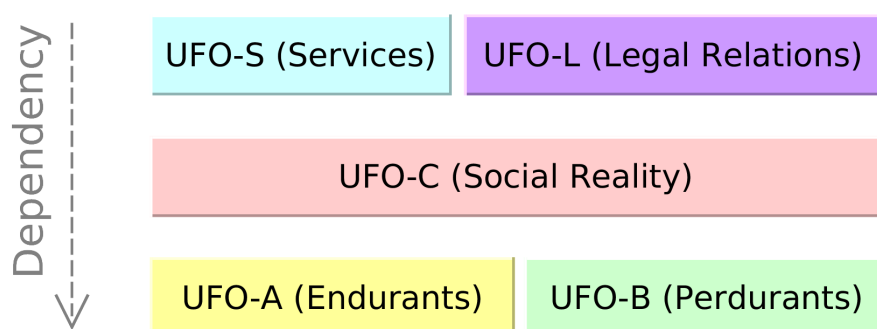
### 1.1.1 Introduction

#### 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

### 1.1.2 UFO Modules

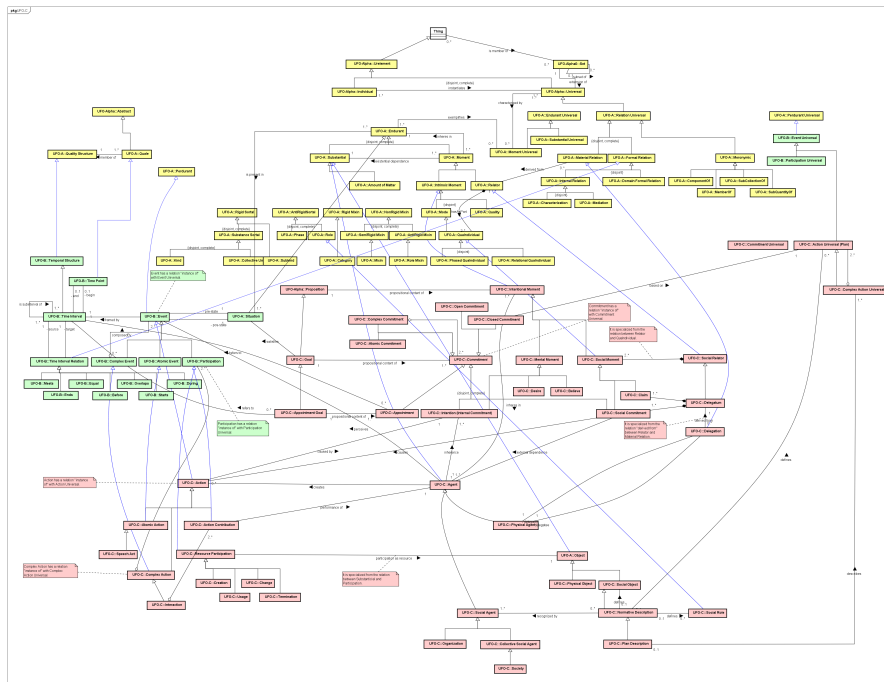
#### UFO Core Modules Structure



## UFO Core Modules Overview<sup>1</sup>

- **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 [guizzardi2005ontological].
- **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 [guizzardi2013towards].
- **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) [guizzardi2008grounding].
- **UFO-S** – on ontology for *commitment-based services* [nardi2013towards].
- **UFO-L** – an ontology representing *legal domain* [griffo2015towards].

## Relations within Core Modules of UFO



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

<sup>1</sup>For detailed overview see [guizzardi2015towards, guizzardi2008grounding]

### 1.1.3 UFO-A

#### Module UFO-A

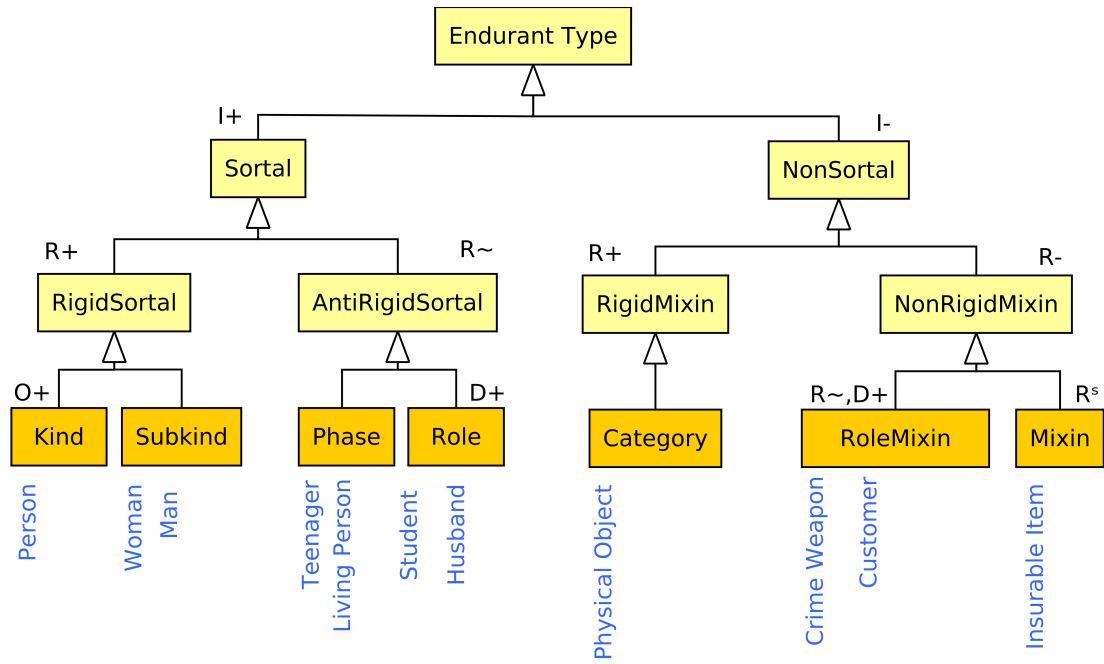
- Module **UFO-A** is ontology of *endurants* dealing with aspects of structural conceptual modeling such types and taxonomic structures, part-whole relations, particularized intrinsic properties, attributes and attribute value spaces, particularized relational properties and relations, role
- *Endurant types* are categorized according to two orthogonal dimensions reflecting:
  - ontological nature of entity being classified (e.g. a *substantial*, a *mode*, a *relator*)
  - meta-properties of entity being classified (e.g. *sortality*, *rigidity*)

#### Ontological Meta-properties of Endurant Types

Let  $\mathbf{T}$  be an endurant type.

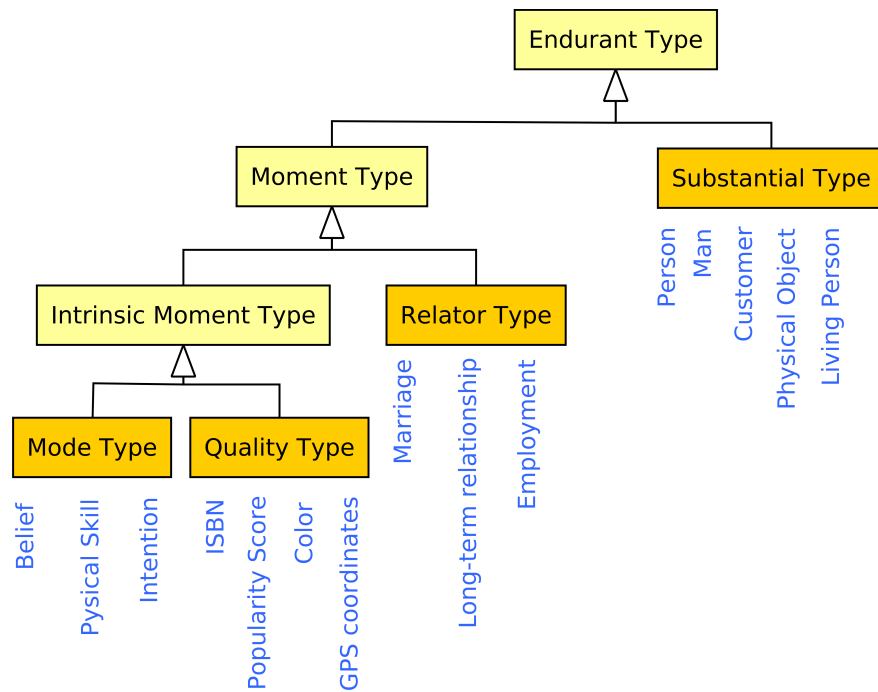
- Identity
  - $\mathbf{I}^+(\mathbf{T})$  – carries identity
  - $\mathbf{O}^+(\mathbf{T})$  – owns (supply) identity
- Rigidity
  - $\mathbf{R}^+(\mathbf{T}) = \Box(\forall x T(x) \rightarrow \Box(T(x)))$  (Rigid)
  - $\mathbf{R}^-(\mathbf{T}) = \neg\mathbf{R}^+(\mathbf{T}) = \Diamond(\exists x T(x)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

#### Classification Based on Meta-properties



For detailed explanation of the categories see <http://guizzardi.panrepa.org/PUE-2016-p3.pdf>

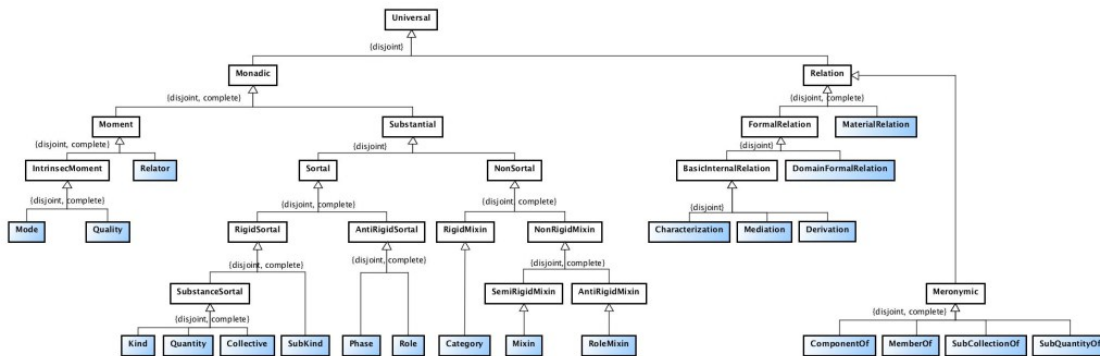
### Classification Based on Ontological Nature



## 1.1 Unified Foundational Ontology

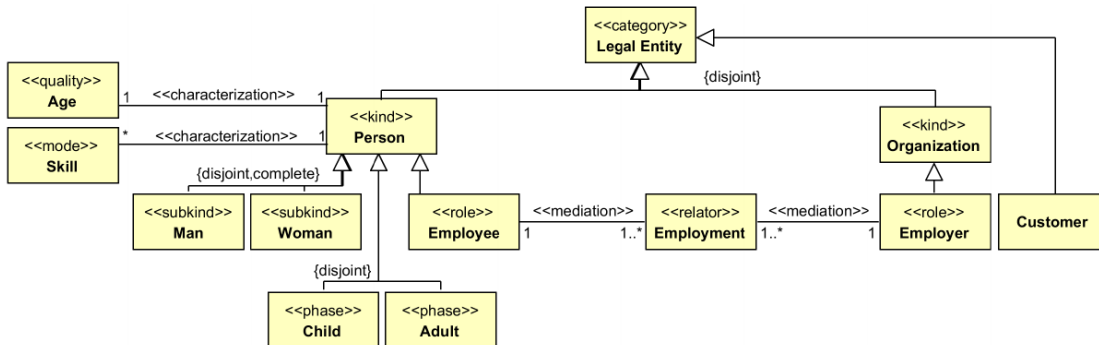
For detailed explanation of the categories see <http://guizzardi.panrepa.org/PUE-2016-p3.pdf>

### 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 [carvalho2017multi].

### 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/>