UFO, OntoUML

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Ontologies and Semantic Web
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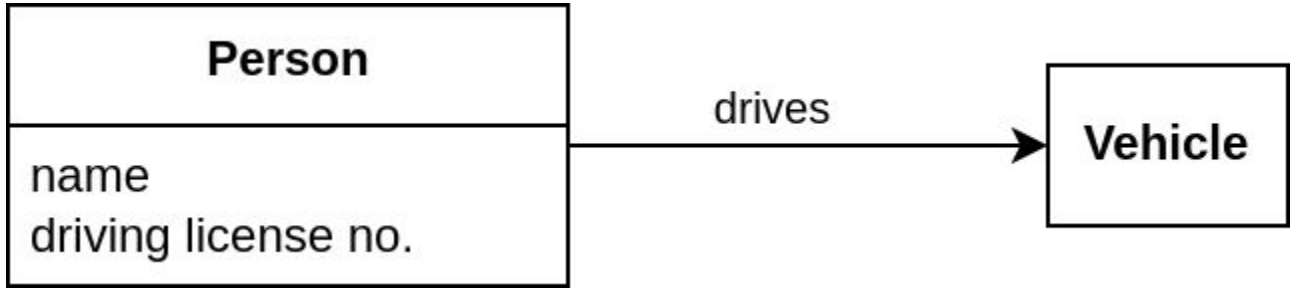
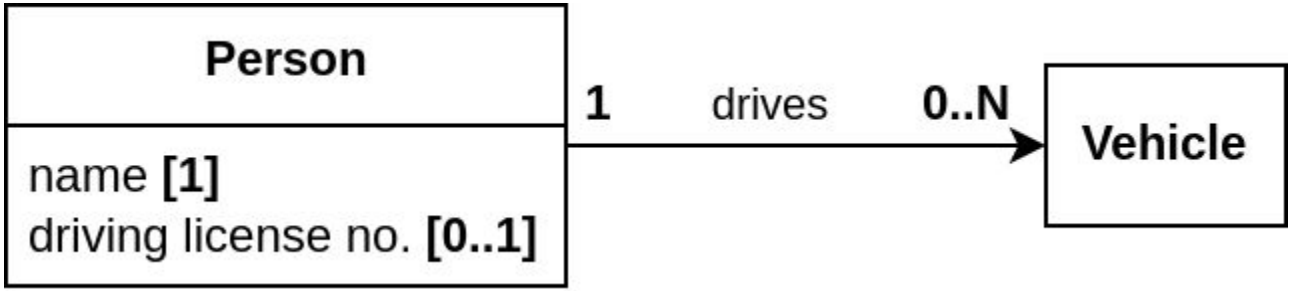
Conceptualization learnt so far




```
# RDFS

:driving-license-no rdfs:domain :Person .
:name rdfs:domain :Person .
:drives rdfs:domain :Person ;
        rdfs:range  :Vehicle .
```

Conceptualization learnt so far

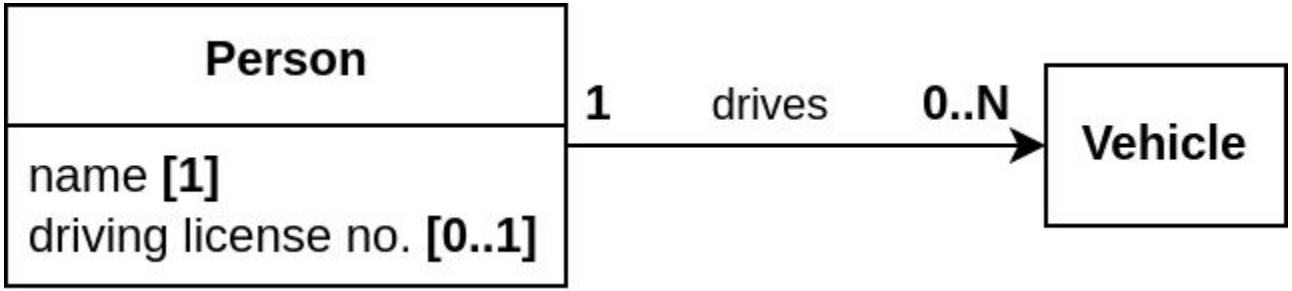



```
# OWL
...
:Vehicle rdfs:subClassOf [  a owl:Restriction ;
  owl:onProperty [ owl:inverseOf :drives] ;
  owl:cardinality 1 .]

:Person rdfs:subClassOf
  [  a owl:Restriction ;  owl:onProperty :driving-license-no ;
owl:maxCardinality 1 .],
  [  a owl:Restriction ; owl:onProperty :name ; owl:cardinality 1 .]
```

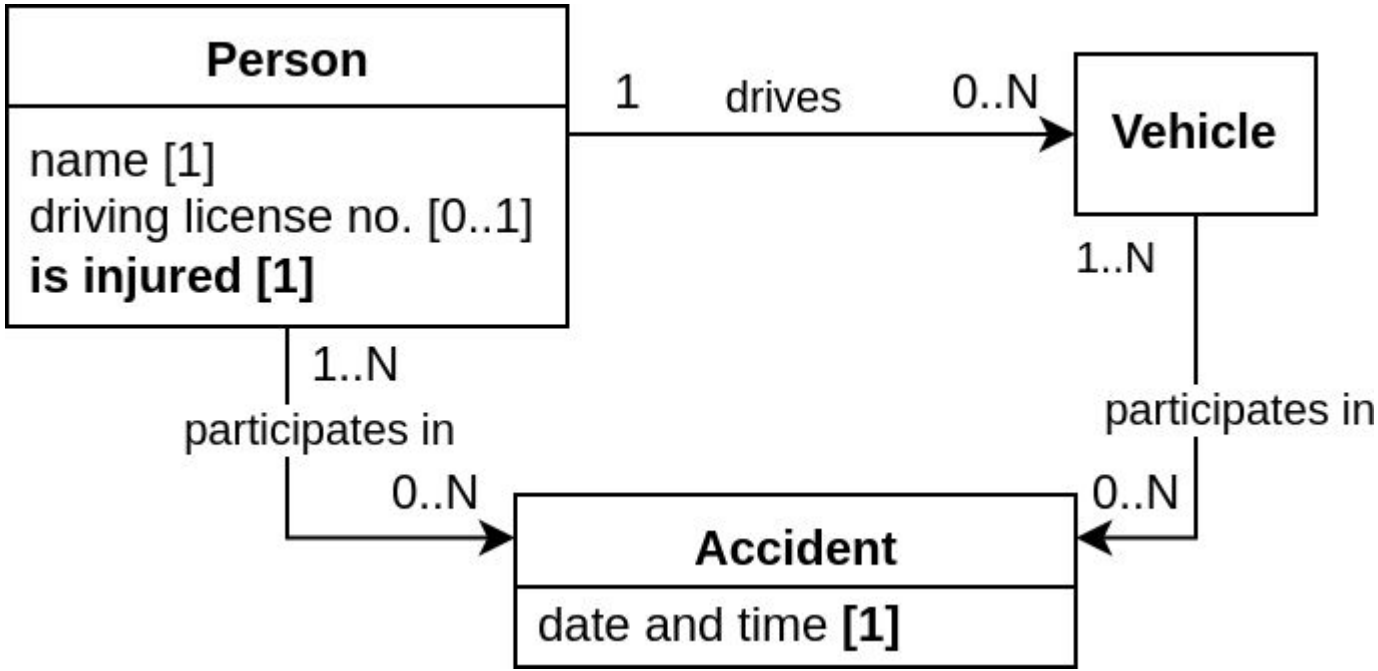
Do we need a representation for 0..N ?

Conceptualization so far



- Who is a person? A physical person? A legal person?
- How to capture, that some people do not have a driving licence, yet they drive a vehicle?
- How to capture, that some people have a driving licence, yet they do not drive a vehicle?

Conceptualization so far



- What does this model imply?
- How to distinguish who is injured and who is not?

Endurant vs. Perdurants

Endurant is a class, instances of which **change their state** (attributes/relationships) over time.
Perdurant is a class, instances of which **do not change their state** (attributes/relationships) over time.

Person

- John's driving license number might change

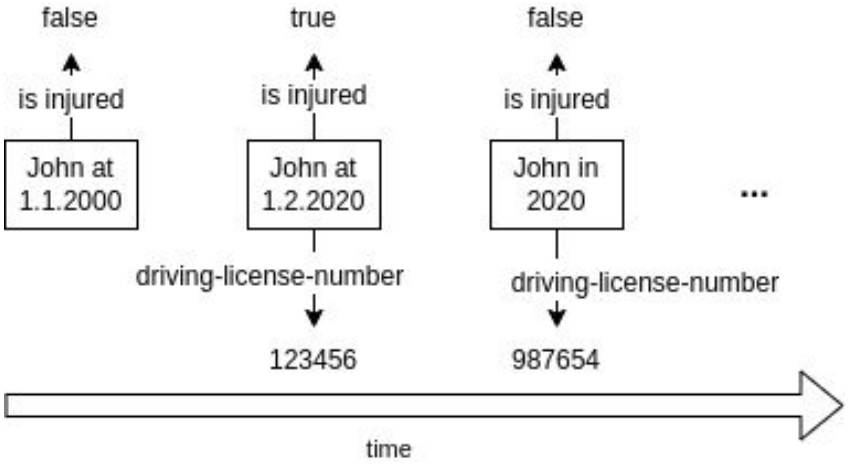
Accident

- a car crash happened at some time point (interval) and cannot change its time/place/participants any more.

Endurant vs. Perdurants

Person

- John's driving license number might change



Accident

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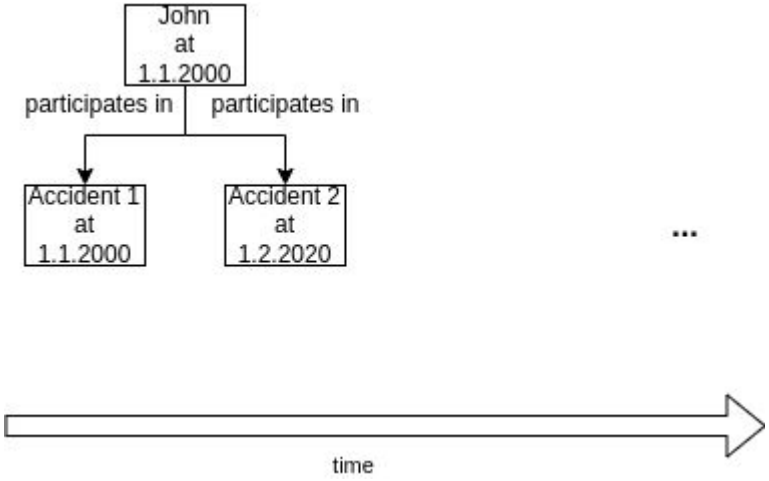
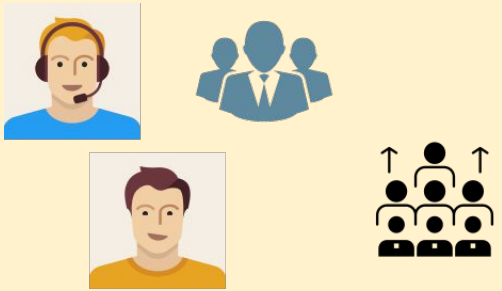


Driving license holder vs. Vehicle Owner

A class is **sortal** if all its instances have the same ***principle of identity***.
A class is **non-sortal** if its instances can be partitioned according to **different principles of identity**.

Driving license holder can always identified by its DNA, because (s)he is a human

Vehicle owner can be identified by DNA (human) or by a business entity id (company).

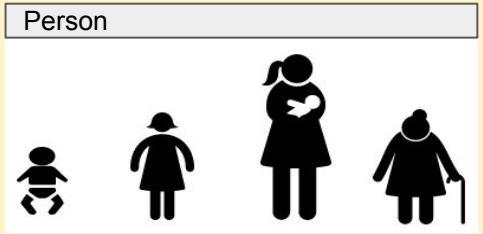


Person vs. Driving license holder

A class is **rigid** if all its instances exist iff they belong to the class.
A class is **anti-rigid** if all its instances sometimes belong to the class during their existence and sometimes do not belong to the class during their existence.

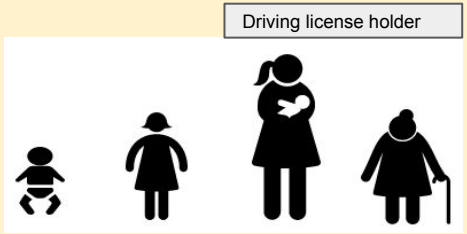
Person

- John Doe was a *Person* the whole its life.



Driving license holder

- John was not a *Driving license holder* in 2000-2020
- John was a *Driving license holder* 2020+



Unified Foundational Ontology (UFO)

How to guide modelers through conceptual model creation ?

- a descriptive foundational ontology by Giancarlo Guizzardi et al.
  - Guizzardi, G. (2005). Ontological foundations for structural conceptual models. Telematica Instituut / CTIT.
- 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

Type/Class characteristics

Let T be an endurant type.

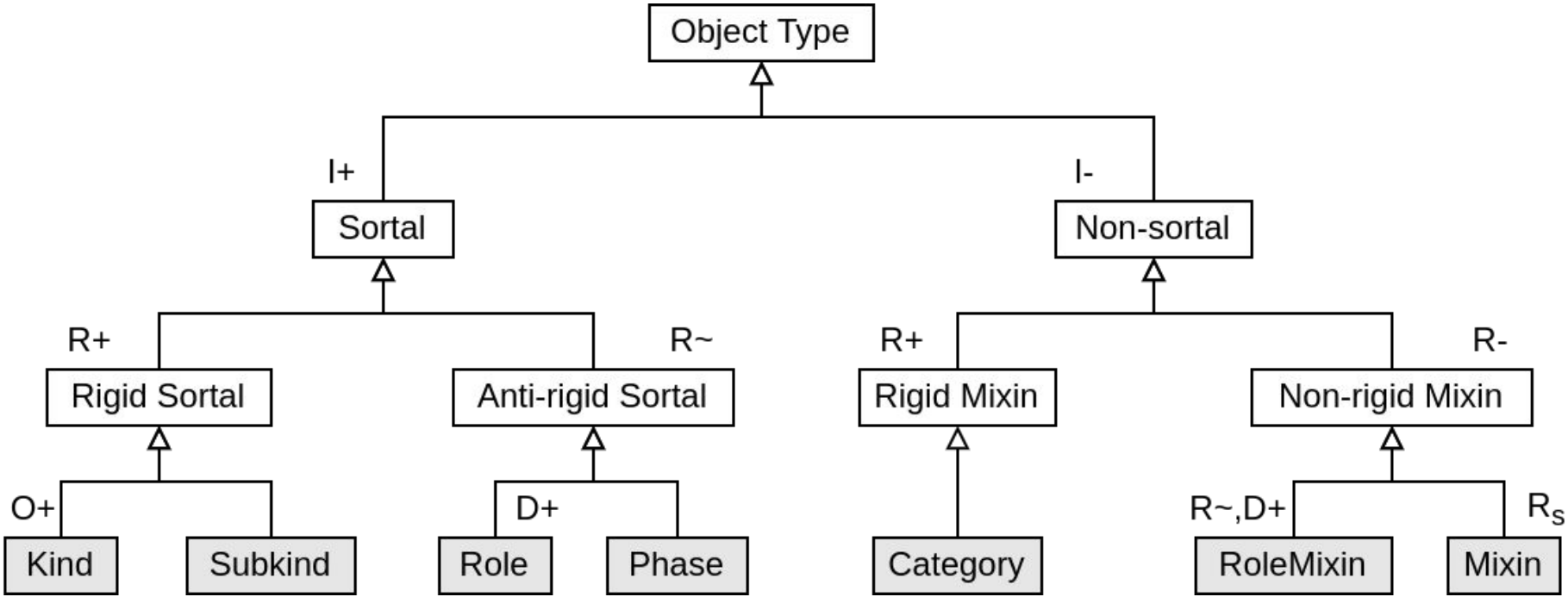
- Identity
  - $I^{+}(T)$ - carries identity
  - $O^{+}(T)$ - supplies identity

- Rigidity
  - $R^{+}(T) = \Box(\forall x\, T(x) \rightarrow \Box T(x))$ (Rigid)
  - $R^{-}(T) = \neg R^{+}(T) = \Diamond(\exists x\, T(x) \wedge \Diamond \neg T(x))$ (Non-Rigid)
  - $R^{\sim}(T) = \Box(\forall x\, T(x) \rightarrow \Diamond \neg T(x))$ (Anti-Rigid)
  - $R^{S}(T) = R^{-}(T) \wedge \neg R^{\sim}(T)$ (Semi-Rigid)

- Relational Dependence
  - $D^{+}(T, T', R) =_{def} \Box(\forall x\, T(x) \rightarrow \exists y\, T'(y) \wedge R(x, y))$

See http://guizzardi.panrepa.org/PUE-2016-p3.pdf

UFO object types



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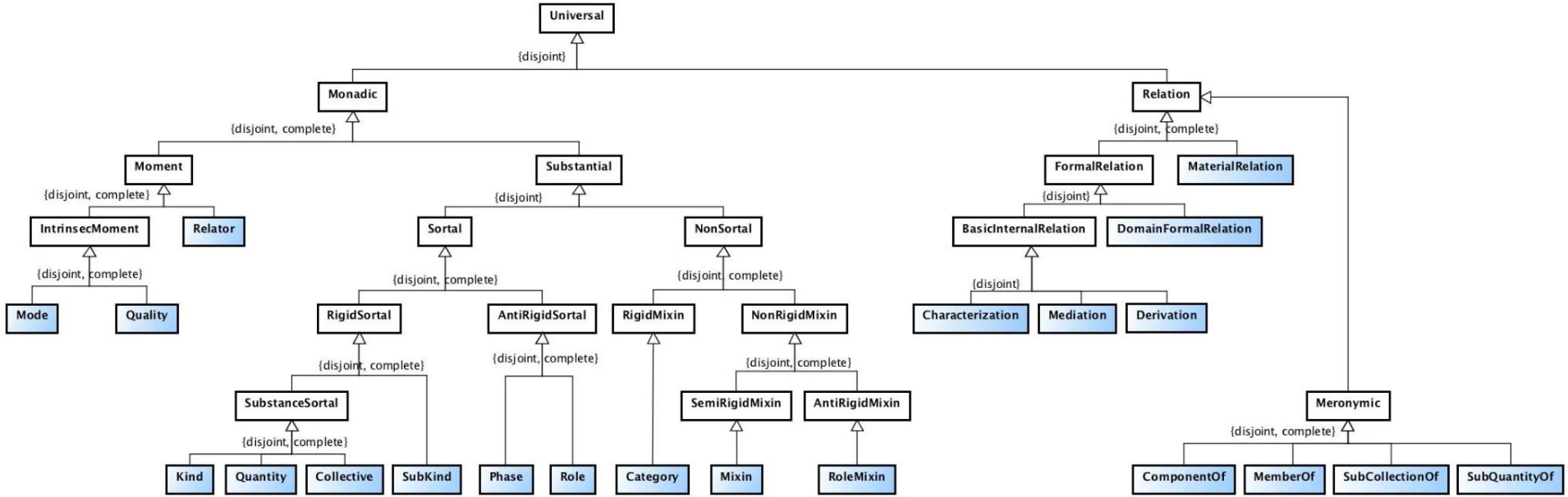
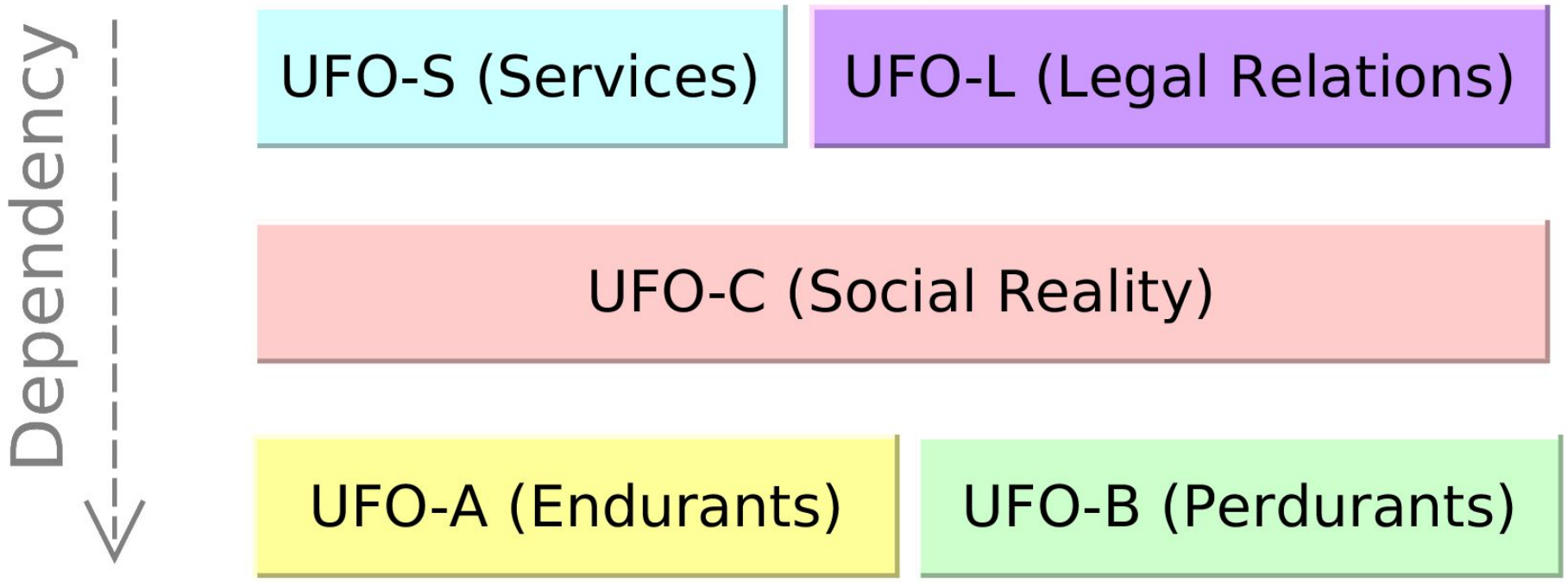
UFO Universal Hierarchy



Taken from https://ontouml.org/ontouml/metamodel-definitions/

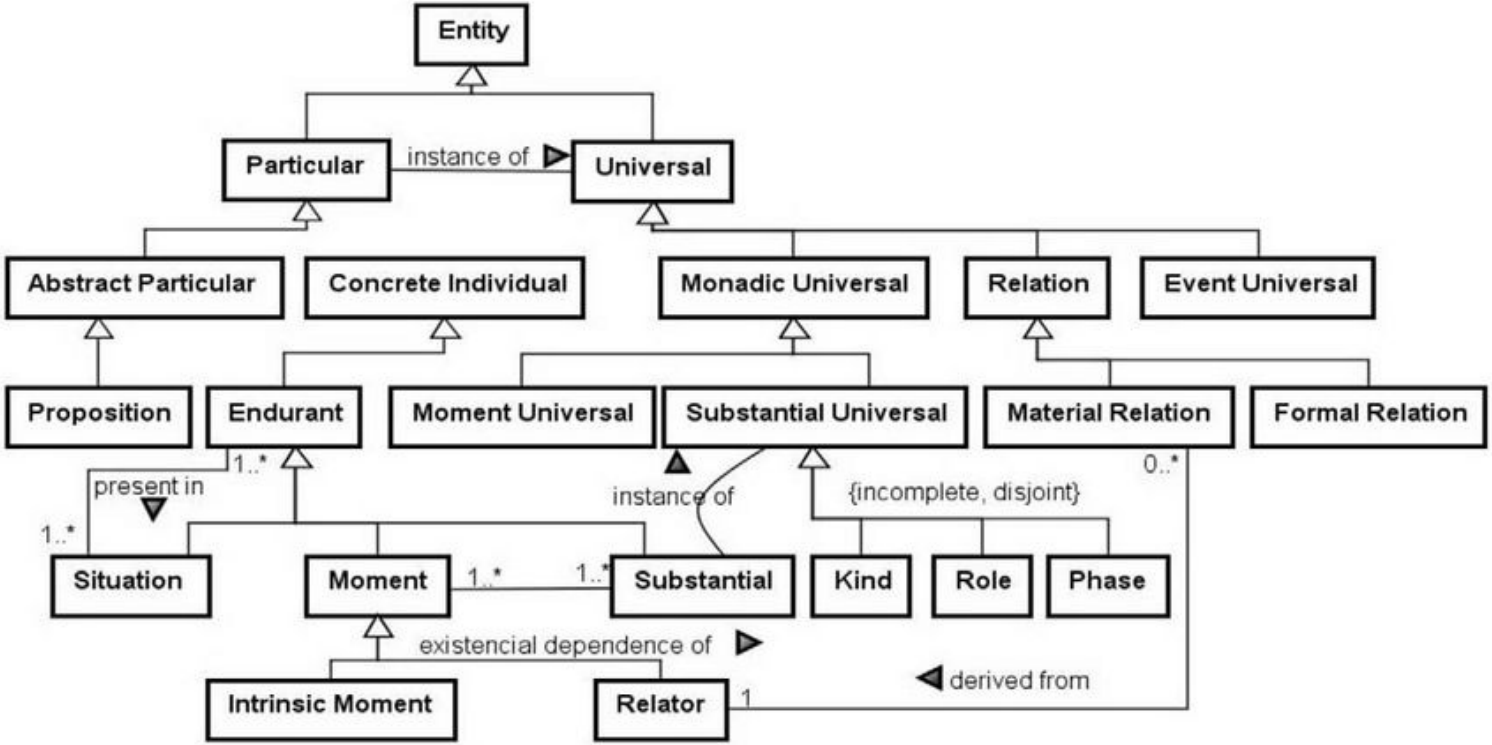
UFO ecosystem



UFO modules

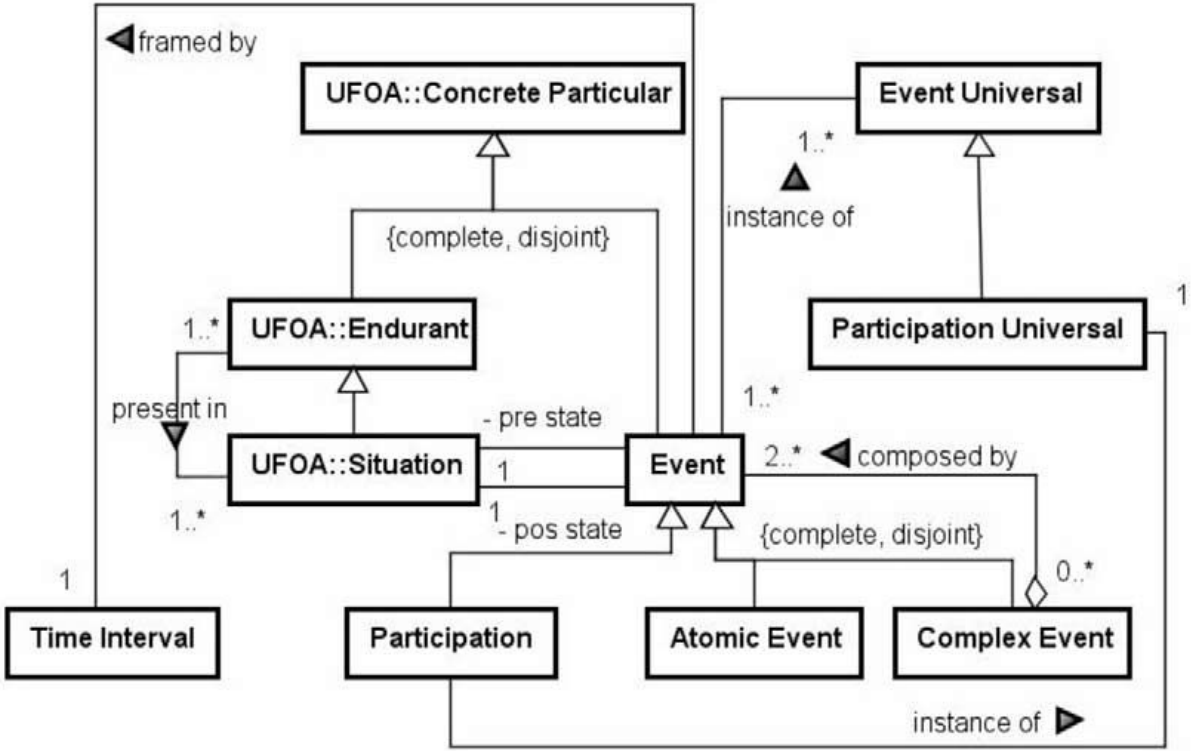
- UFO-A
  - an ontology of endurants dealing with aspects of structural conceptual modeling such types and taxonomic structures, part-whole relations, particularized intrinsic properties, attributes and attribute value spaces, particularized relational properties and relations, roles [guizzardi2005ontological]
- 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 perdurans and endurants via dispositions [guizzardi2005ontological]
- 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 for legal domain [[griffo2015towards].
- UFO-MLT
  - multi-level theory modeling

UFO-A Essentials



From: *Rodrigues, Cleyton & Bezerra, Camila & Freitas, Fred & Oliveira, Ítalo. (2020). Handling Crimes of Omission by reconciling a criminal core ontology with UFO. Applied Ontology. 15. 1-33. 10.3233/AO-200223.*

UFO-B Essentials



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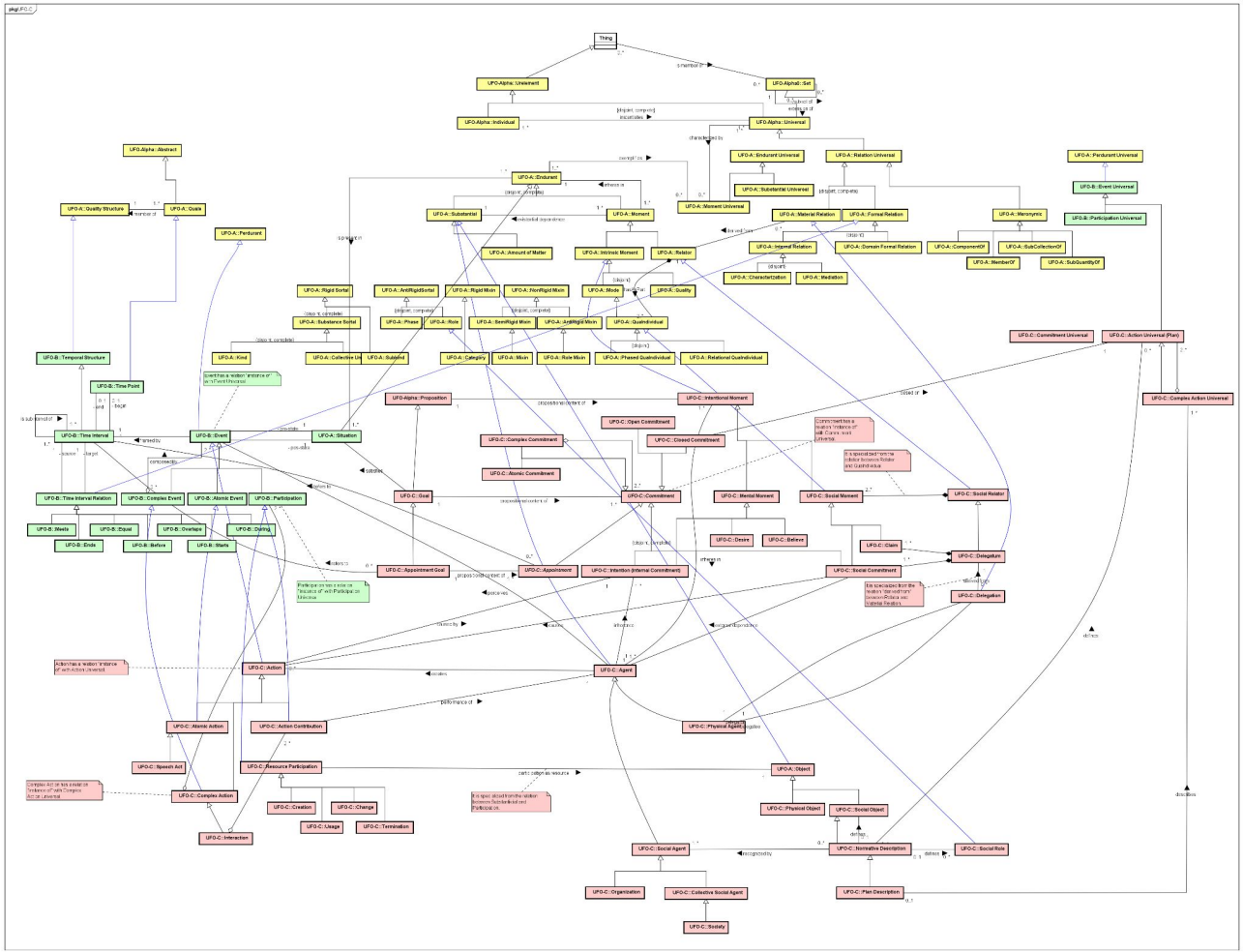
Excerpt of UFO model

- yellow - UFO-A
- green - UFO-B
- red - UFO-C



Taken from https://ontouml.org/ontouml/metamodel-definitions/

OntoUml basics

OntoUML is an extension of UML based on UFO.

Class stereotypes

- Kind
- Subkind
- Role
- Phase
- Category
- RoleMixin
- Mixin
- Relator
- Mode
- Quality
- Collective
- Quantity

Association stereotypes

- Formal
- Mediation
- MaterialDerivation
- Characterization
- Structuration
- Part-Whole Relations
- ComponentOf
- SubCollectionOf
- MemberOf
- Containment
- SubQuantityOf

Taken from https://ontouml.org/ontouml

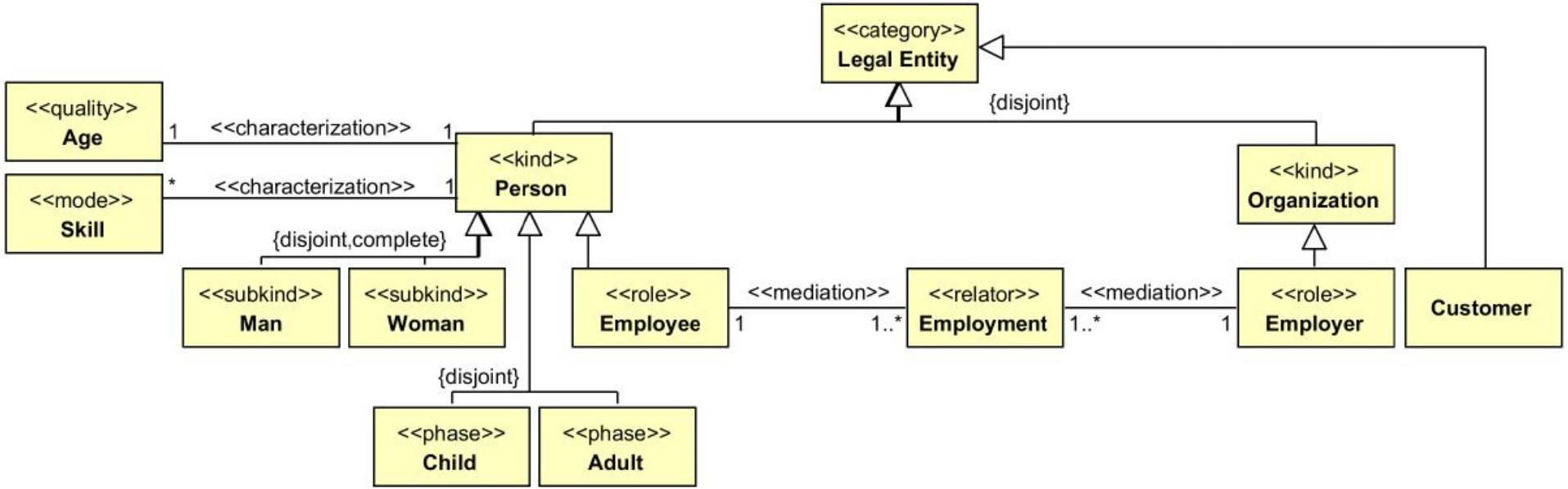
OntoUml constraints examples

OntoUML stereotypes define constraints for conceptual models.

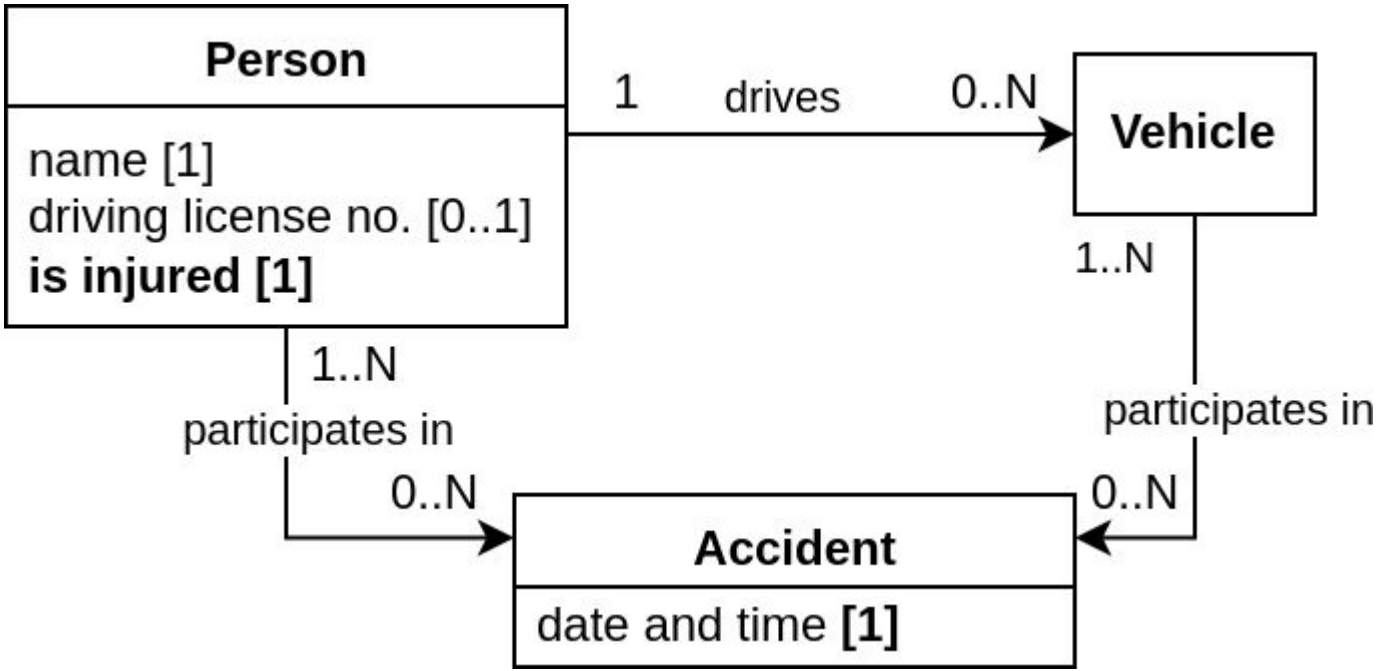
- Kind cannot specialize Kind, SubKind, Role, Phase
- Anti-rigid sortals must have a single Kind higher in the hiearchy
- Non-sortals cannot specialize Kinds
- Rigid types cannot specialize Anti-rigid types

Taken from https://ontouml.org/ontouml

OntoUml Example



How to OntoUmlize this example?



Reference

1. *Guizzardi, Giancarlo. (2005). Ontological Foundations for Structural Conceptual Models. PhD Thesis.*
2. *Rodrigues, Cleyton & Bezerra, Camila & Freitas, Fred & Oliveira, Ítalo. (2020). Handling Crimes of Omission by reconciling a criminal core ontology with UFO. Applied Ontology. 15. 1-33. 10.3233/AO-200223.*