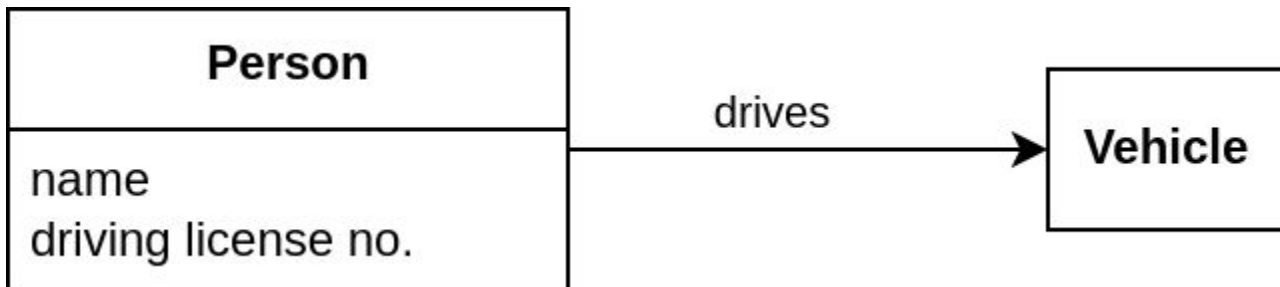


UFO, OntoUML

Petr Křemen

Ontologies and Semantic Web
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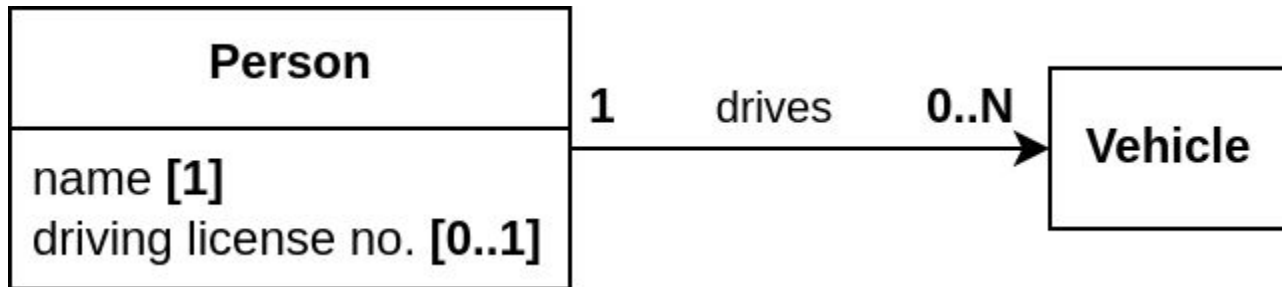
Conceptualization learnt so far



RDFS

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

Conceptualization learnt so far

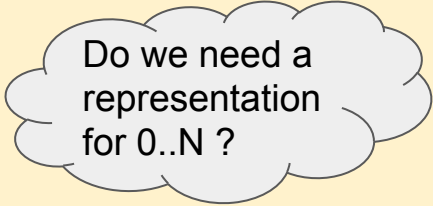


OWL

...

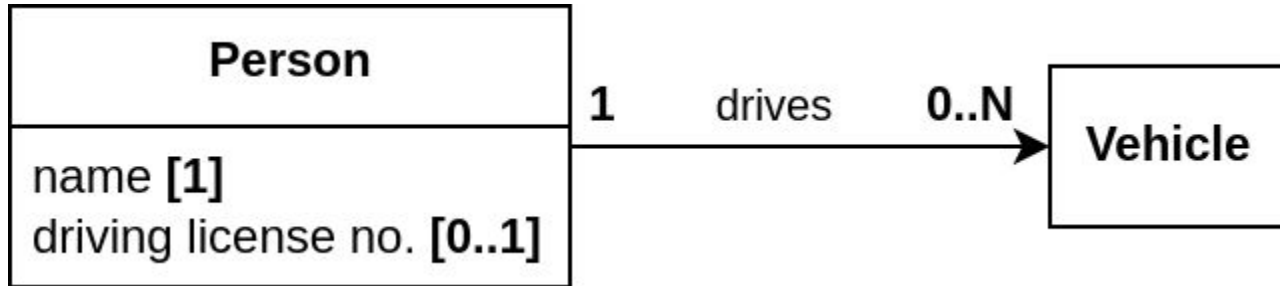
```
:Vehicle rdfs:subClassOf [ a owl:Restriction ;
    owl:onProperty [ owl:inverseOf :drives ] ;
    owl:cardinality 1 .]
```

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



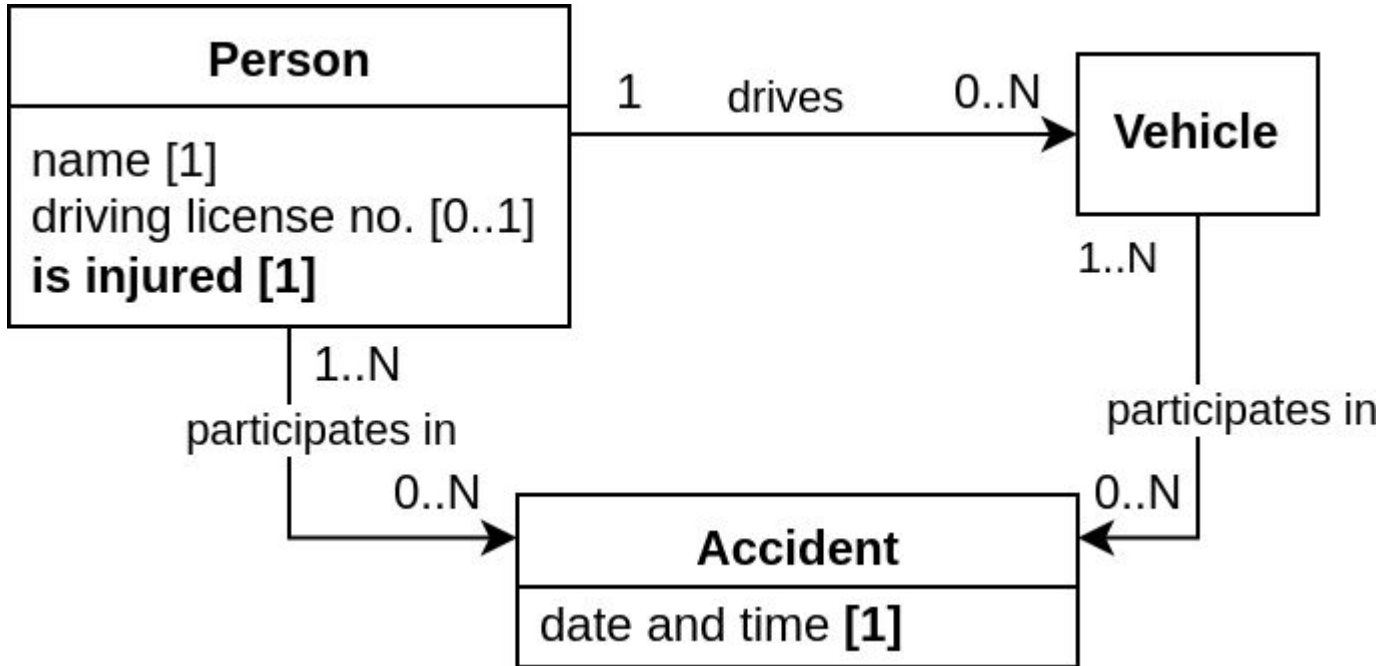
Do we need a representation for 0..N ?

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

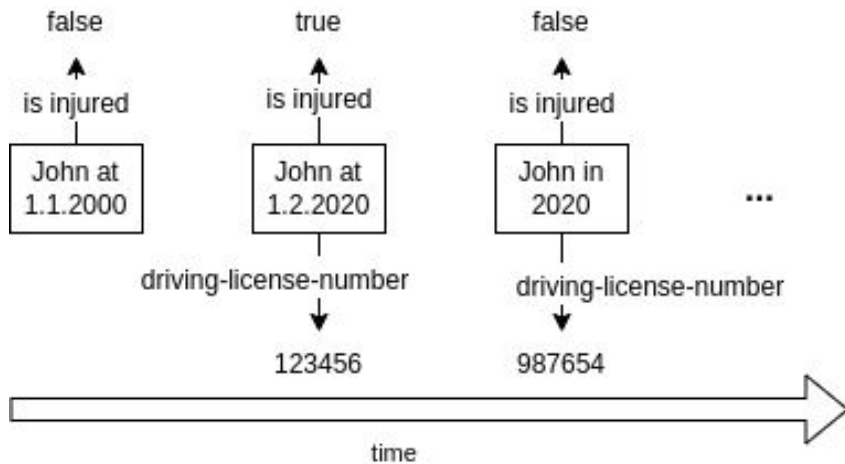
Accident

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

Endurant vs. Perdurants

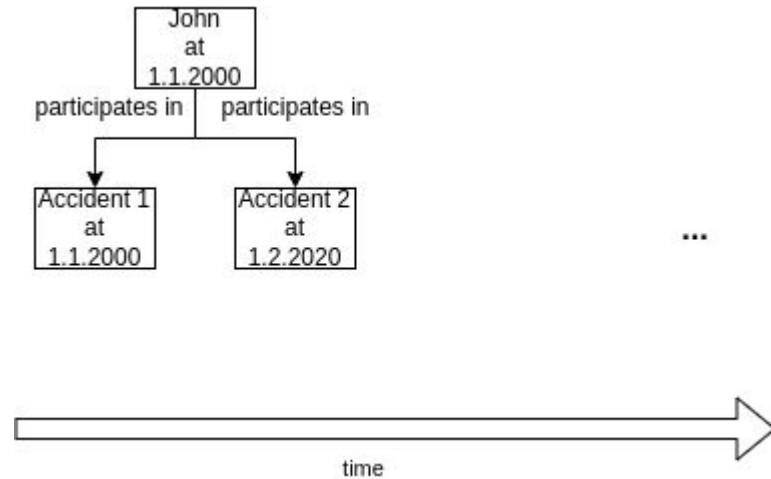
Person

- John's driving license number might change



Accident

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



Driving license holder vs. Vehicle Owner

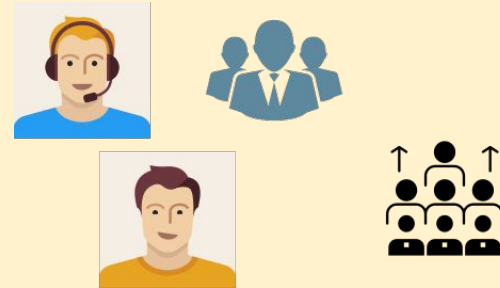
A class is **sortal** if all its instances have the same *principle of identity*.

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

Driving license holder can always be 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.

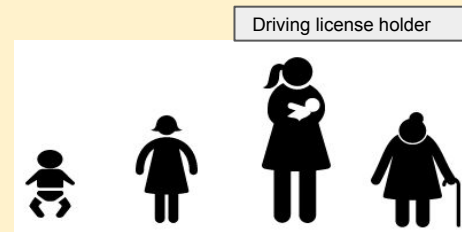
Person

- 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

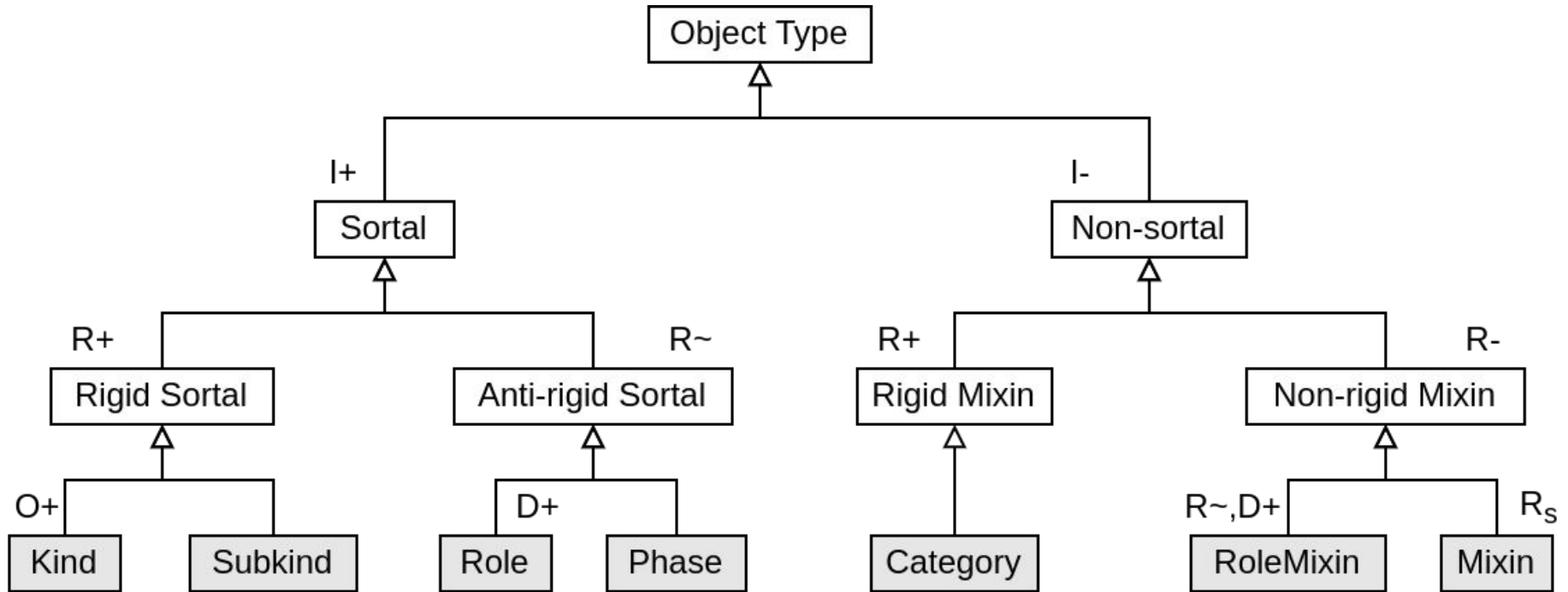
- Rigidity

- $R^+(T) = \Box (\forall x T(x) \rightarrow \Box T(x))$ (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)

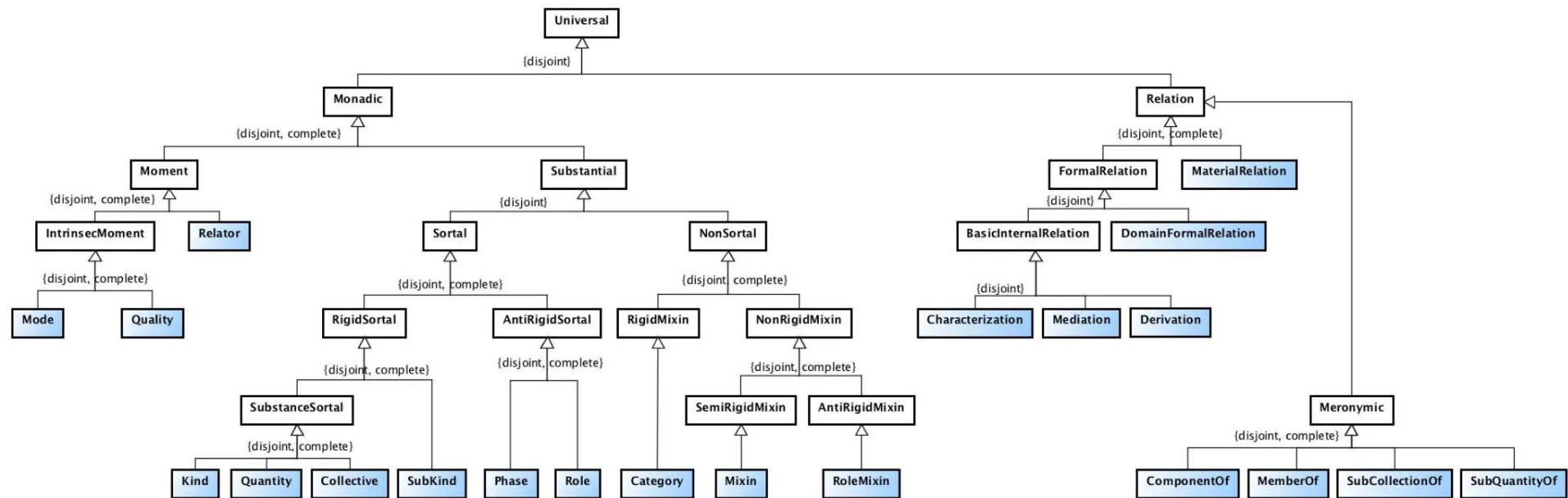
- Relational Dependence

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

UFO object types



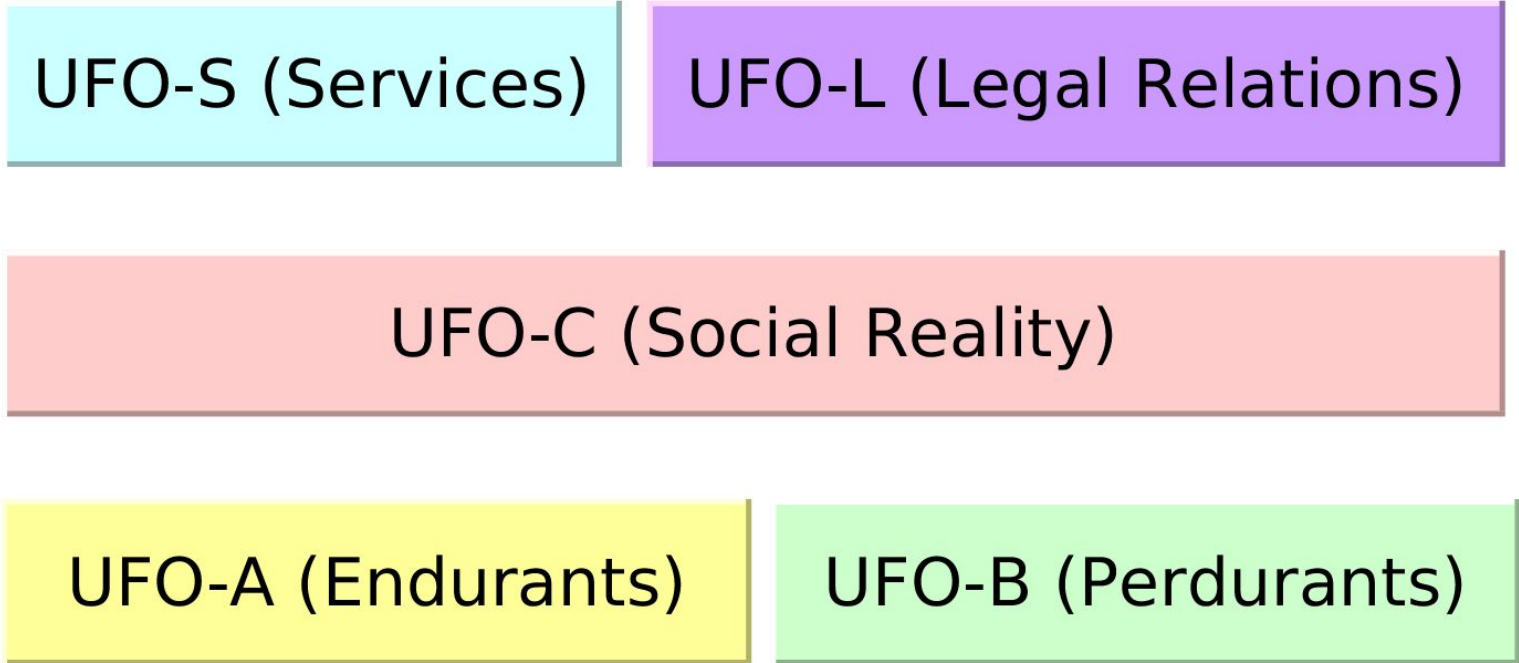
UFO Universal Hierarchy



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

UFO ecosystem

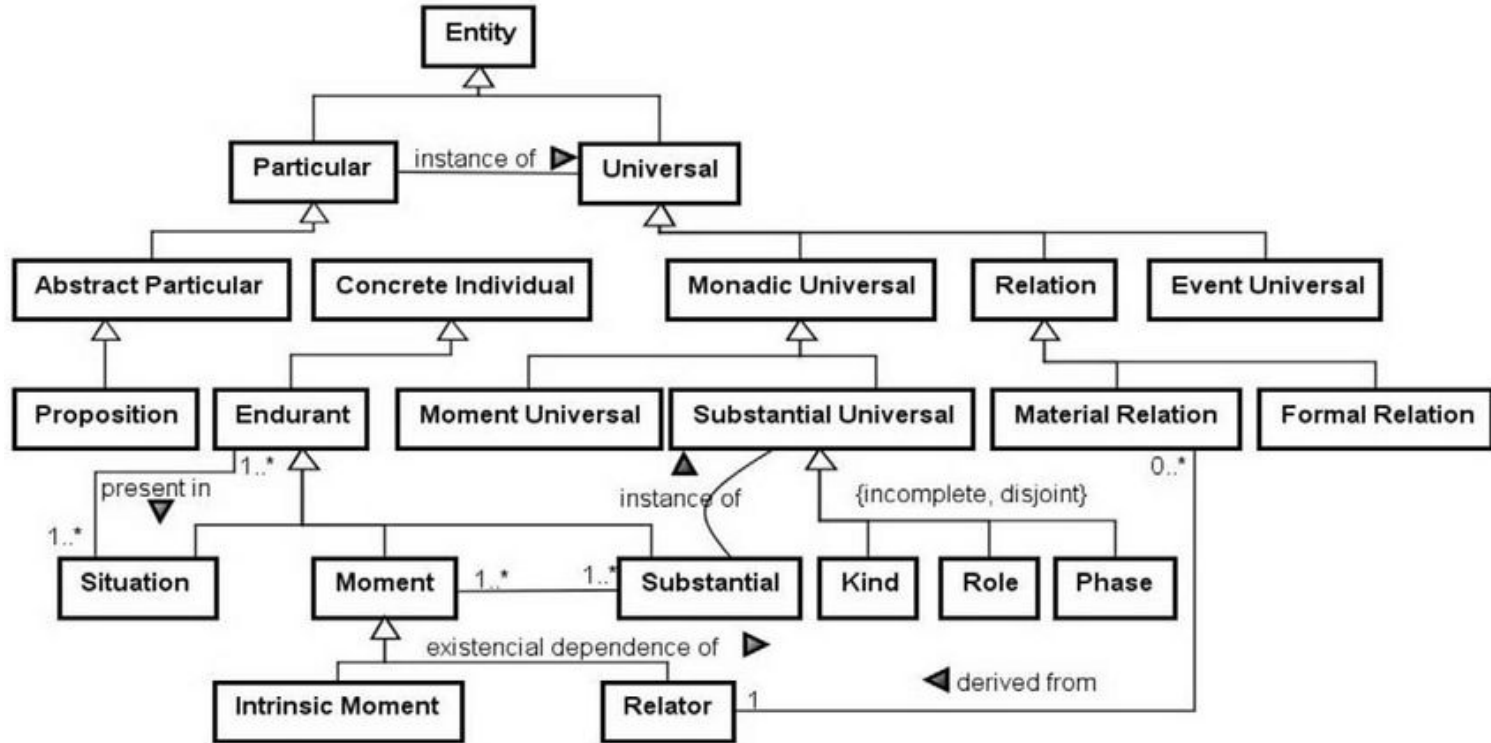
Dependency
↓



UFO modules

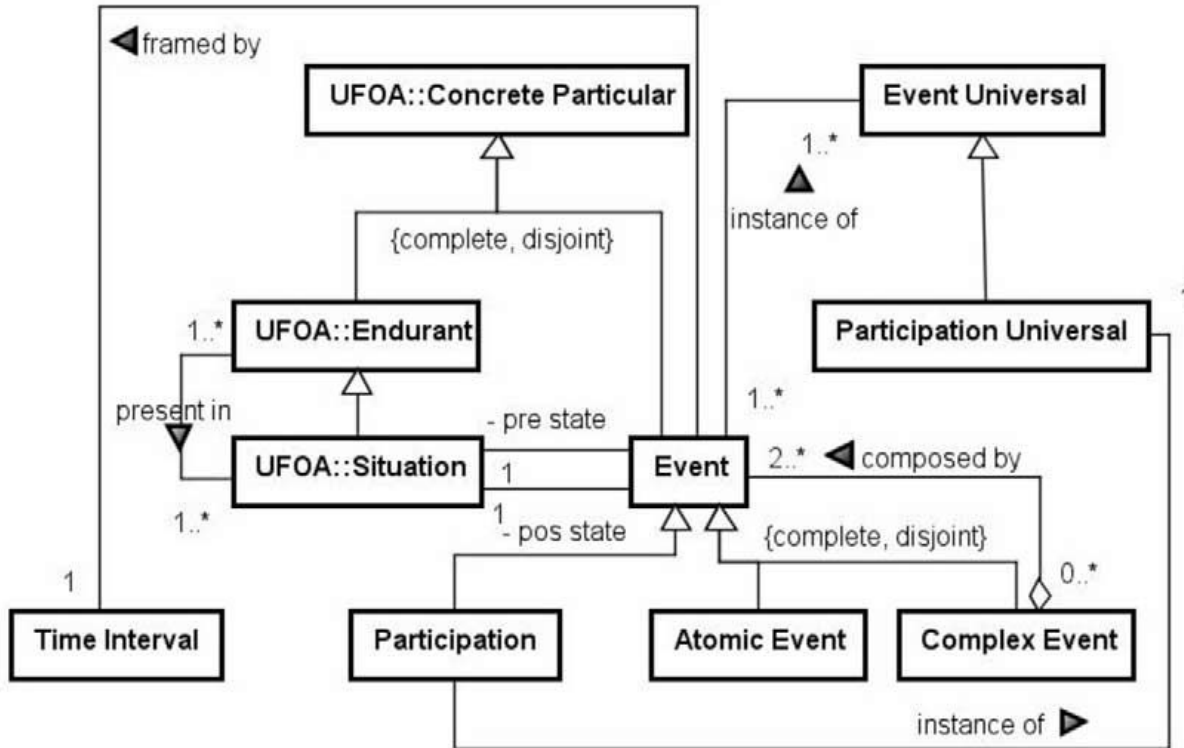
- UFO-A
 - an ontology of endurants dealing with aspects of structural conceptual modeling such types and taxonomic structures, part-whole relations, particularized intrinsic properties, attributes and attribute value spaces, particularized relational properties and relations, roles [guizzardi2005ontological]
- 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 perdurants 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



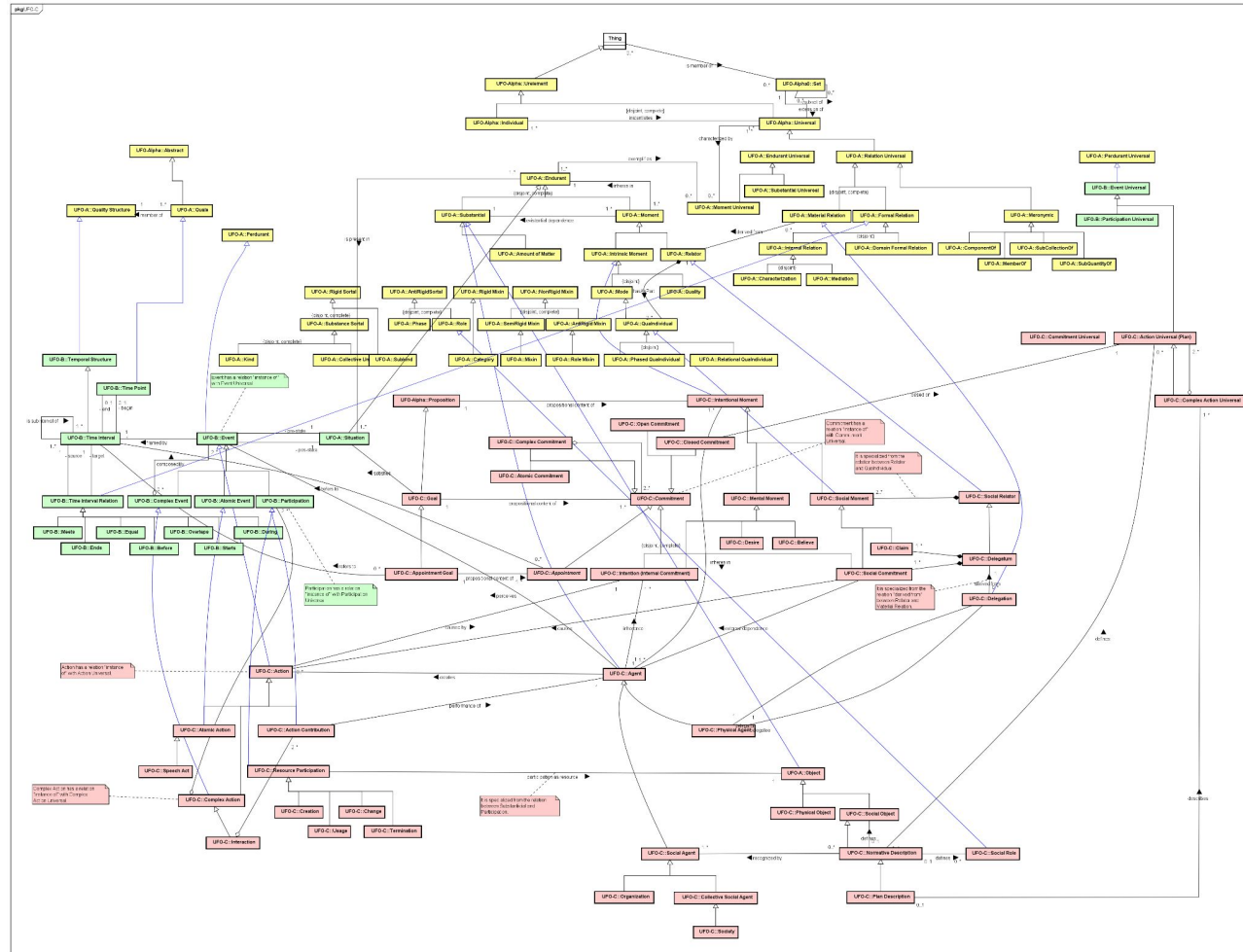
From: Rodrigues, Cleyton & Bezerra, Camila & Freitas, Fred & Oliveira, Ítalo. (2020). Handling Crimes of Omission by reconciling a criminal core ontology with UFO. *Applied Ontology*. 15. 1-33. 10.3233/AO-200223.

UFO-B Essentials



Excerpt of UFO model

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



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

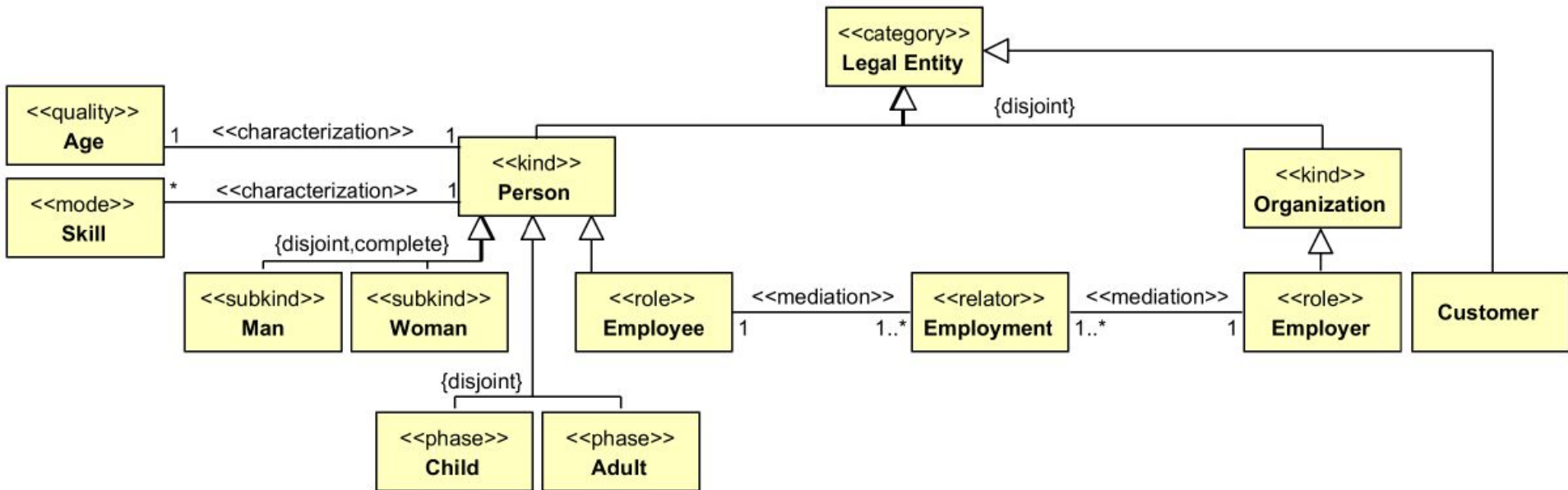
- Formal
- Mediation
- MaterialDerivation
- Characterization
- Structuration
- Part-Whole Relations
- ComponentOf
- SubCollectionOf
- MemberOf
- Containment
- SubQuantityOf

OntoUml constraints examples

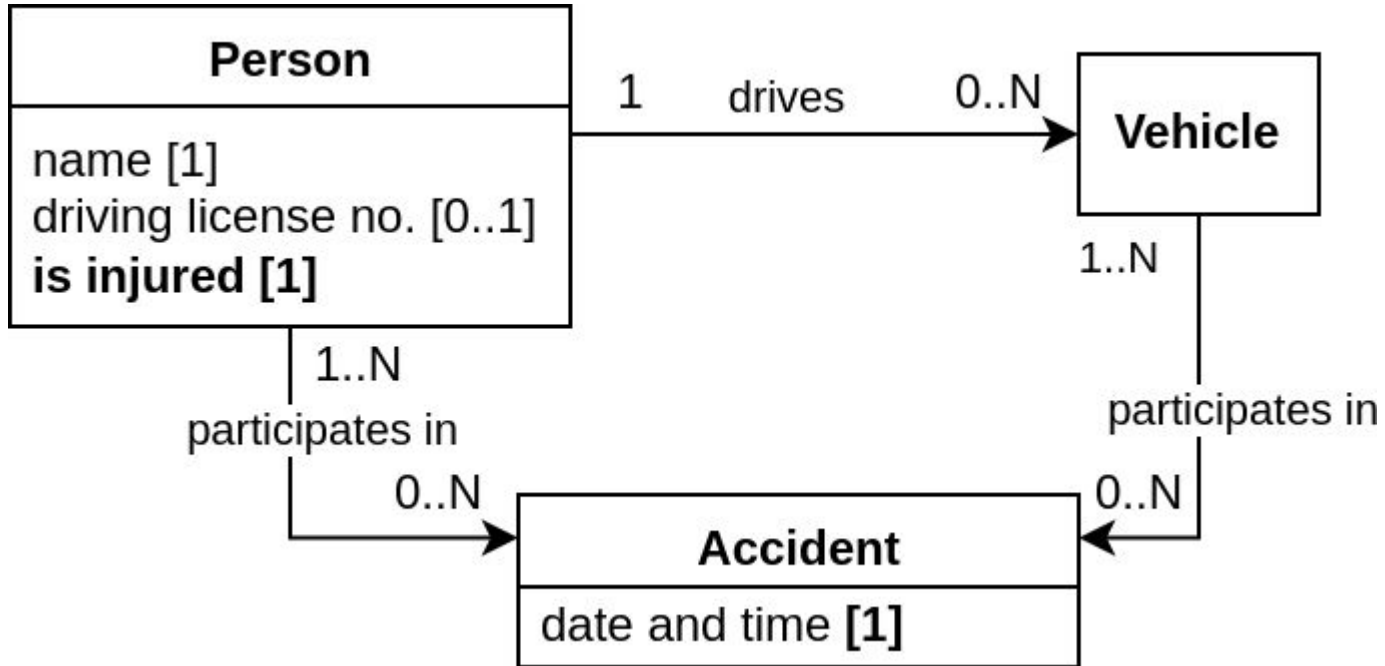
OntoUML stereotypes define constraints for conceptual models.

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

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.*