

UFO

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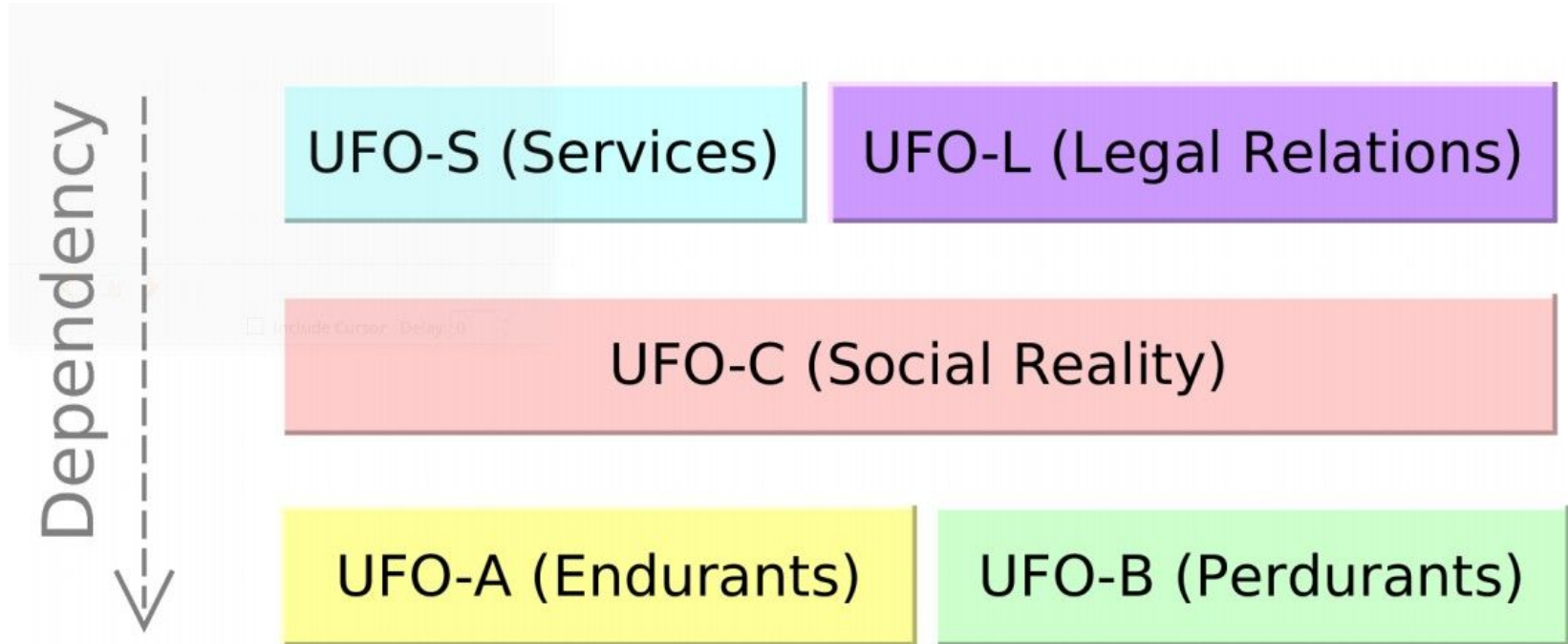
Basic terms

- **Conceptualization** - is set of objects which an observer thinks that they exist in target world (world of interest). It provides backbone of the conceptual structure of such world.
- **Ontology** - “explicit specification of conceptualization” (Gruber)
 - It contains hierarchically organized structure of concepts and relations between them. Such structure defines meaning of objects appearing in the target world.
 - It is declarative description of fundamental understanding of the target world.

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
- ontology/theory to contribute to the general goal of serving as a Foundation for Conceptual Modeling
- 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



UFO modules overview (1/2)

- **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) dealing with dynamic aspect including perdurant mereology, temporal ordering of perdurants, object participation in perdurants, causation, change and the connection between perdurants and endurants via dispositions [guizzardi2013towards].

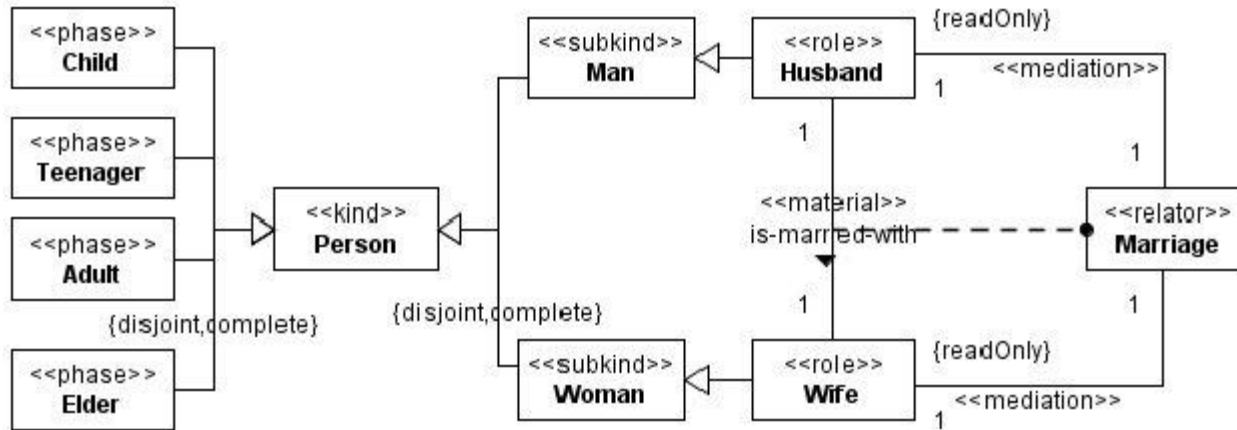
UFO modules overview¹ (2/2)

- **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** – an ontology for commitment-based services [nardi2013towards].
- **UFO-L** – an ontology representing legal domain [griffo2015towards].

¹ For detailed overview of all modules see also [guizzardi2015towards, guizzardi2008grounding]

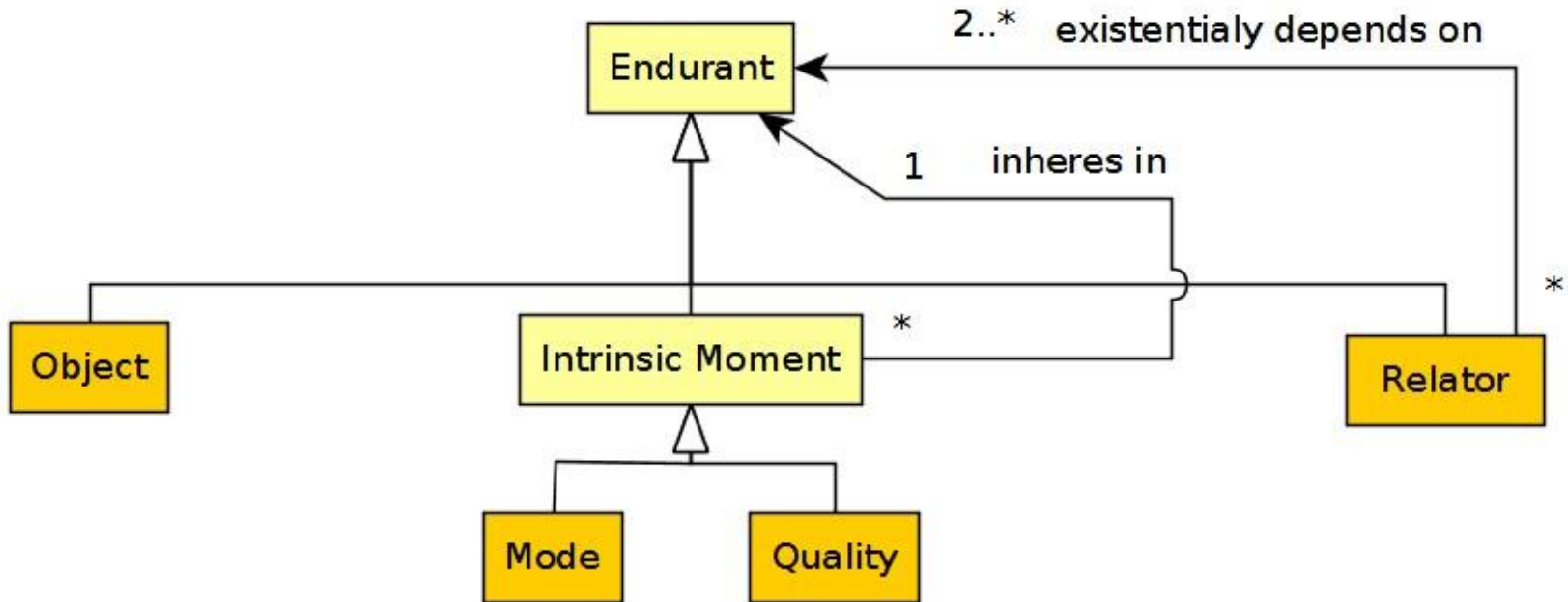
OntoUML

- ontologically well-founded language for ontology-driven conceptual modeling
- UML extension based on UFO
 - defines new stereotypes for classes and relations in class diagrams
 - defines additional constraints based on stereotypes



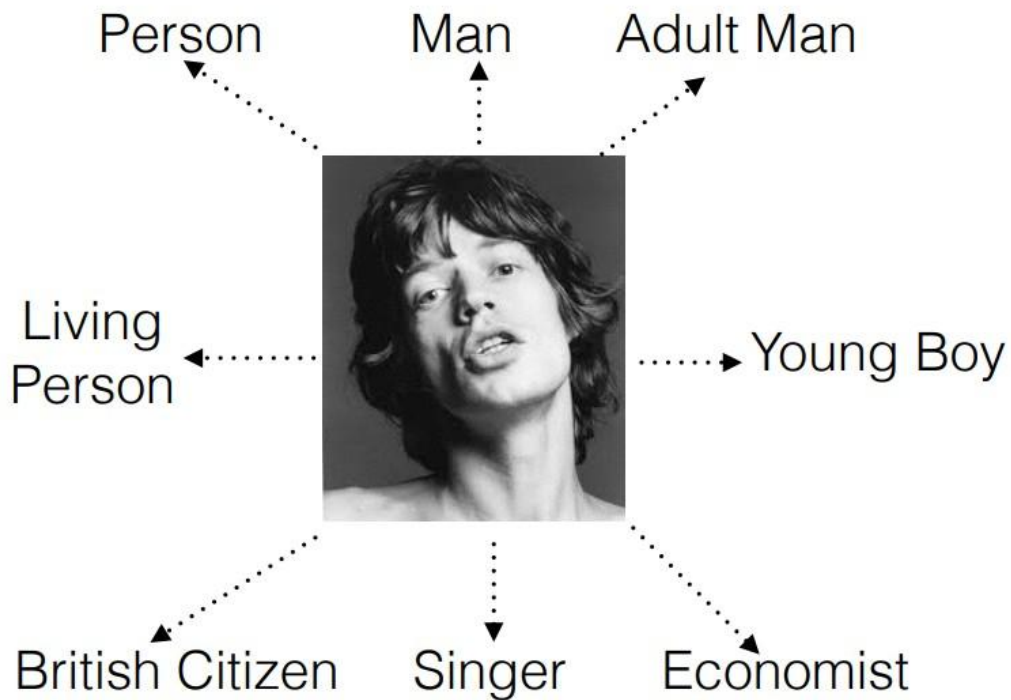
UFO-A

Basic structure of Endurants

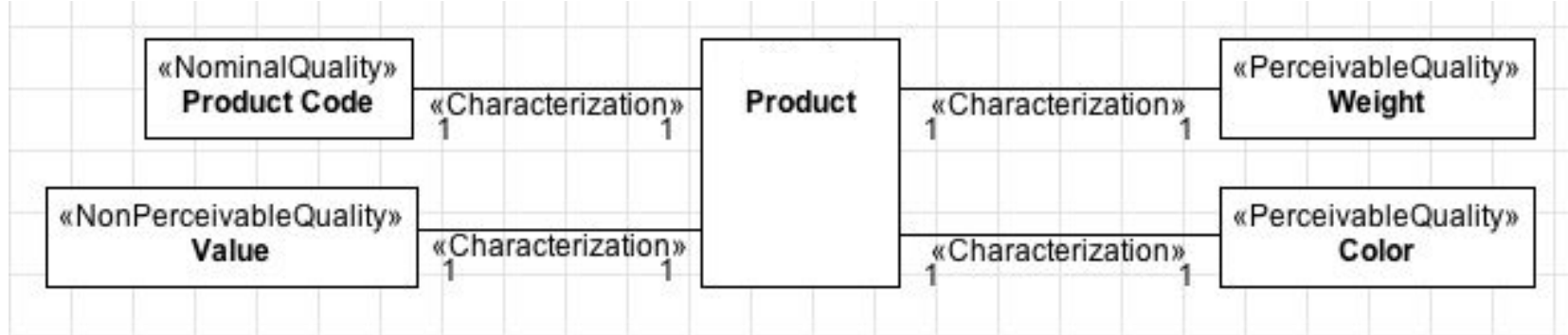


Note: Existentially dependent endurants (i.e. Intrinsic Moments and Relators) are also called Aspects.

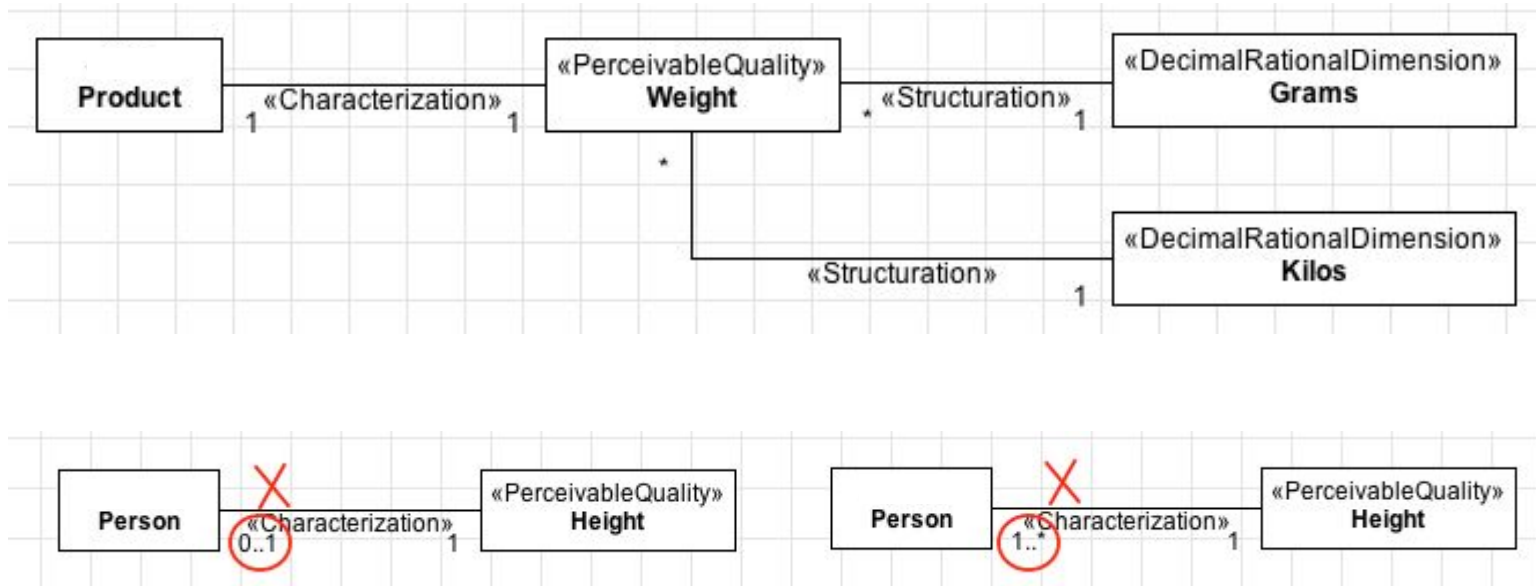
Objects - examples



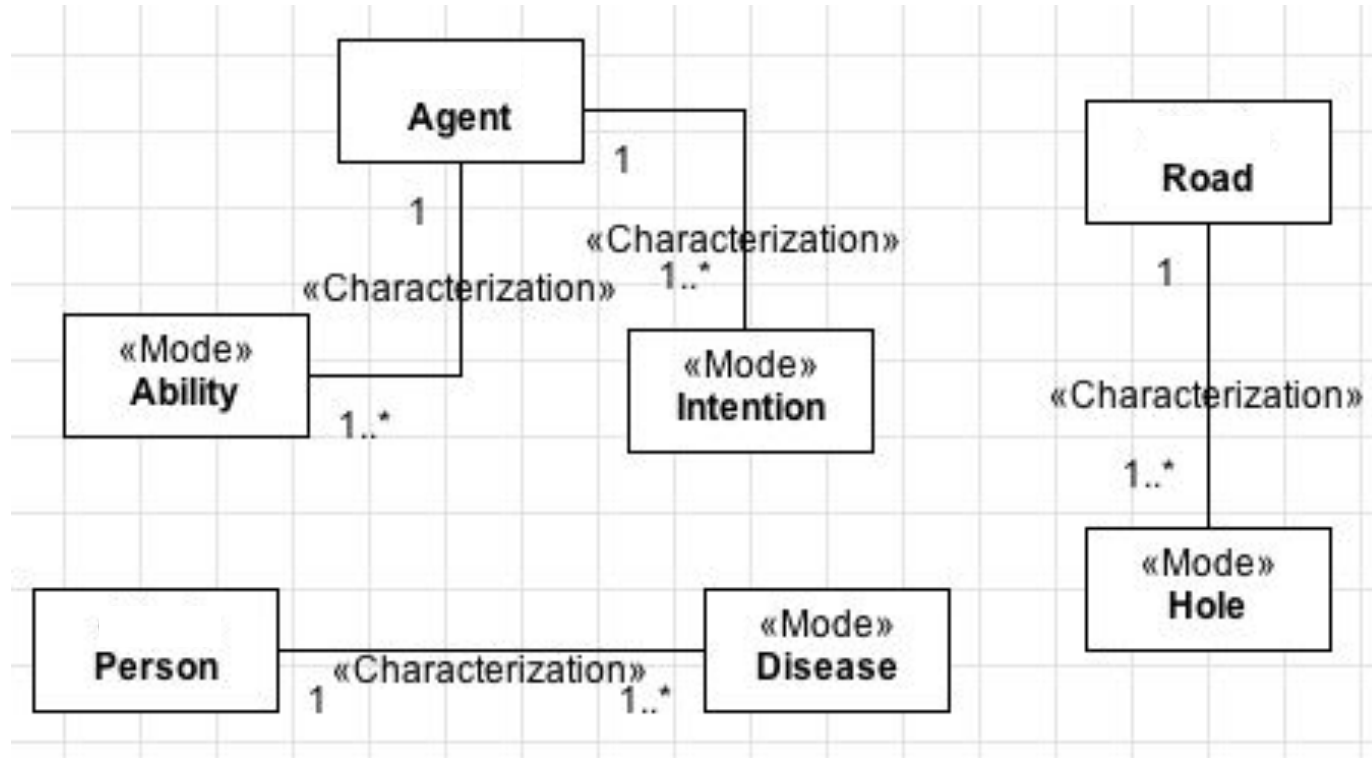
Quality - examples



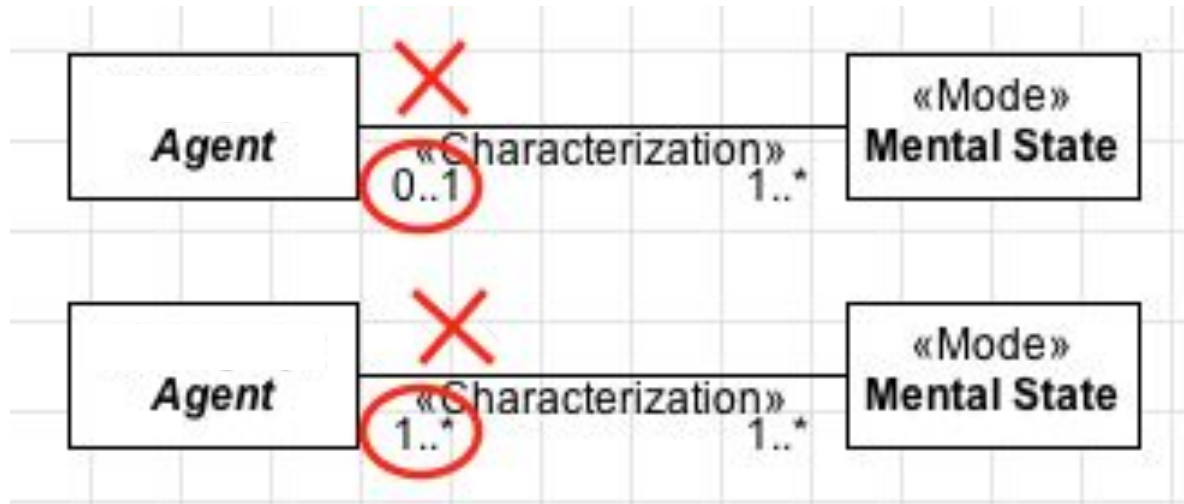
Quality - properties and constraints



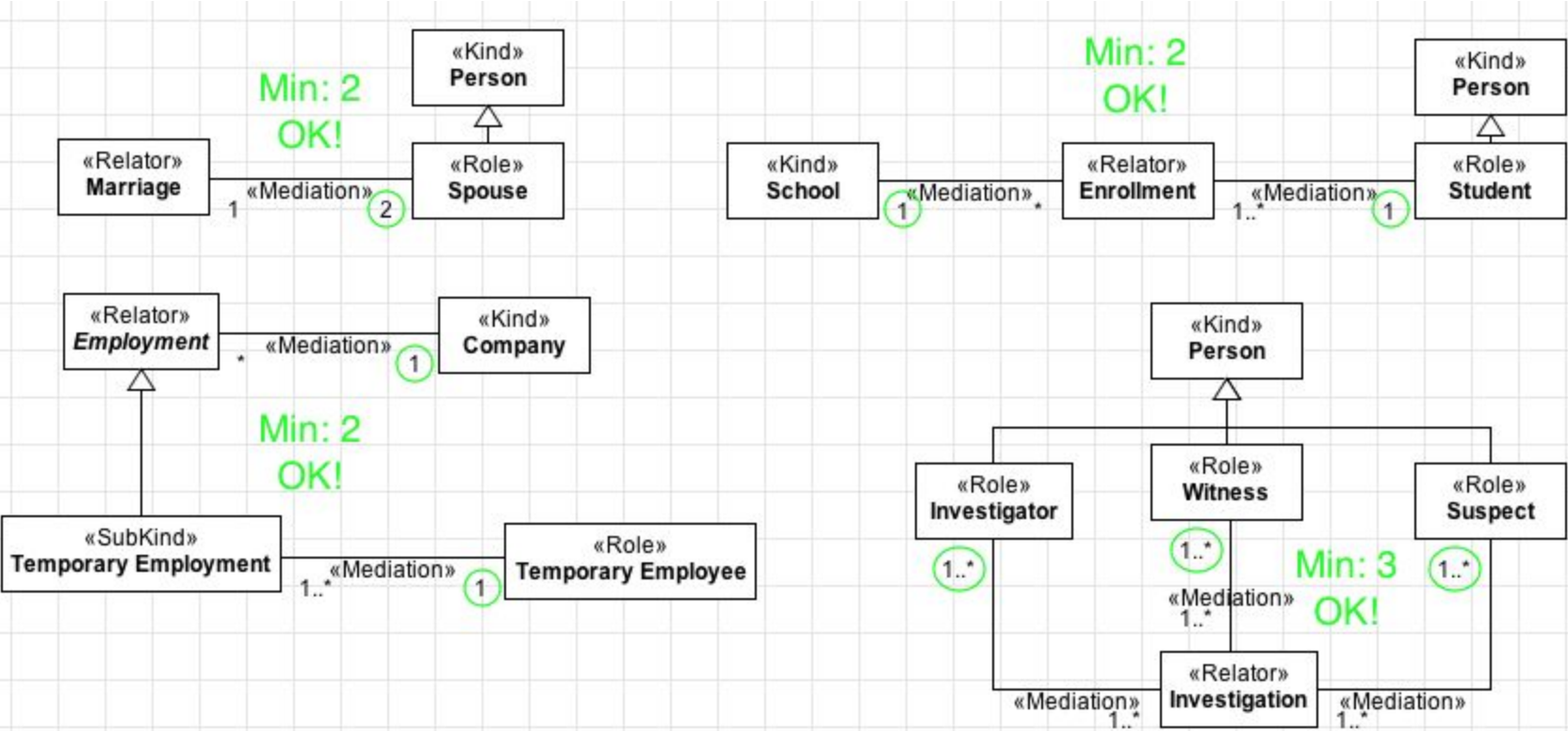
Mode - examples



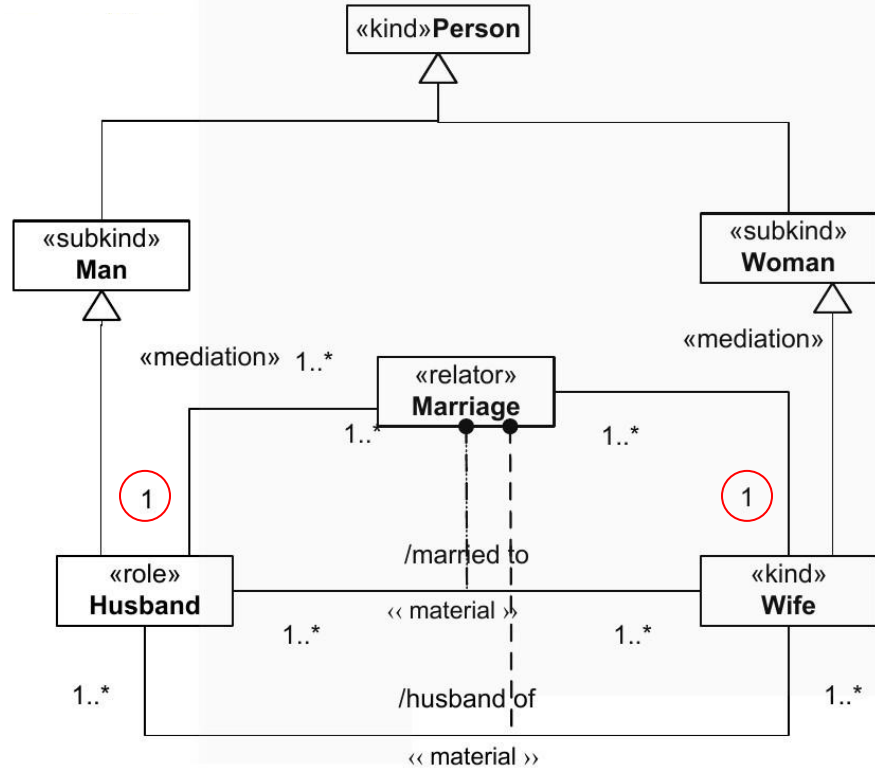
Mode - constraints



Relator - examples



Relator and material relations



Meta-properties of endurant types

- So far we classified endurant types according to *ontological nature*
- Alternative way to classify endurant types is according to its *meta-properties*:
 - Identity
 - Rigidity
 - Relational dependance
 - ...

Identity

- How are following concepts different ?
 - Blue thing, Physical object, Entity
 - Person, Table
 - Student, Wooden Table

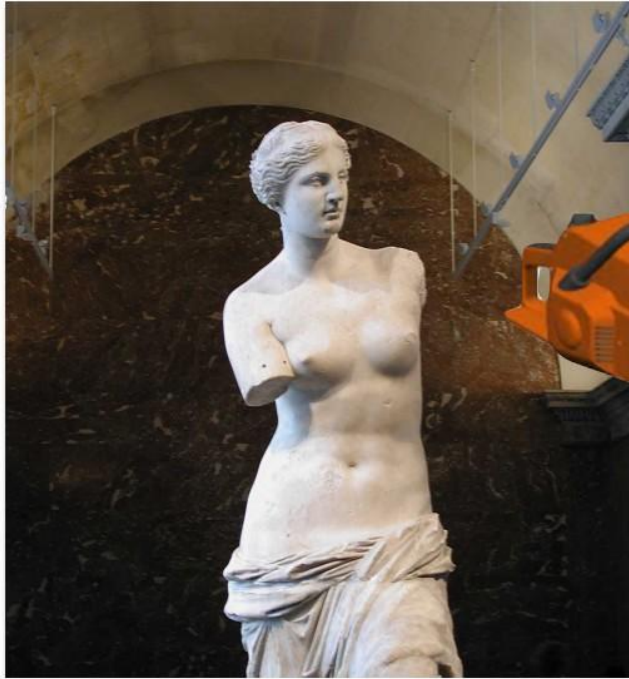
Identity



= ?



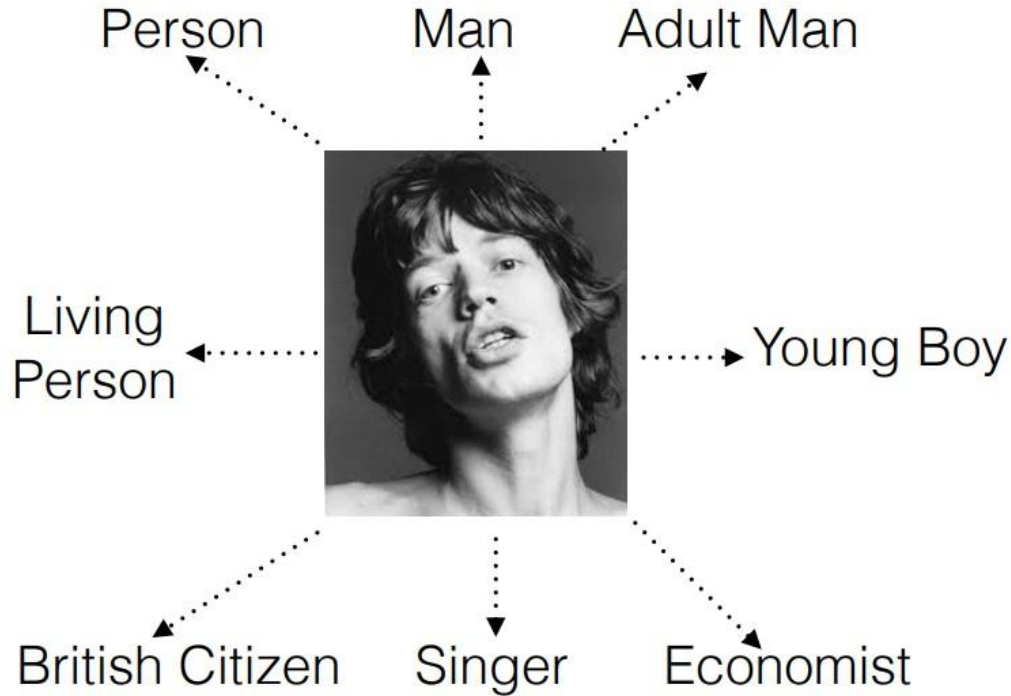
Identity



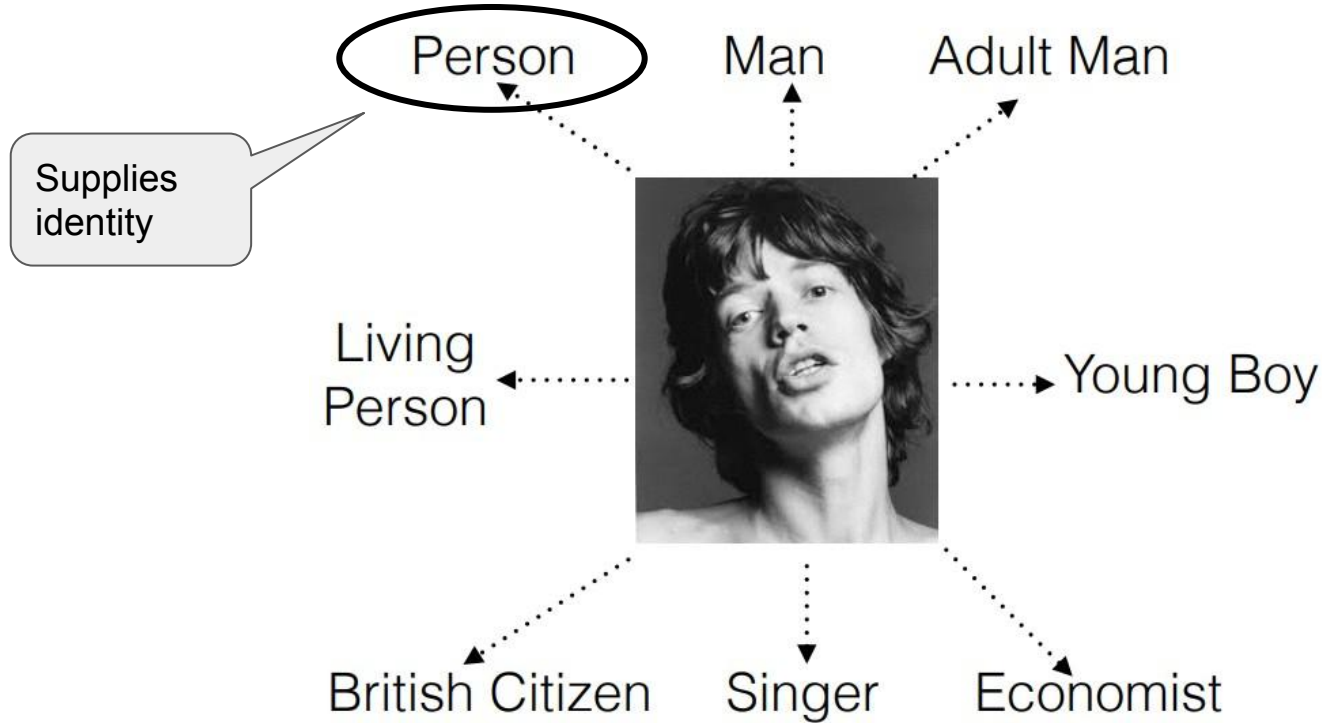
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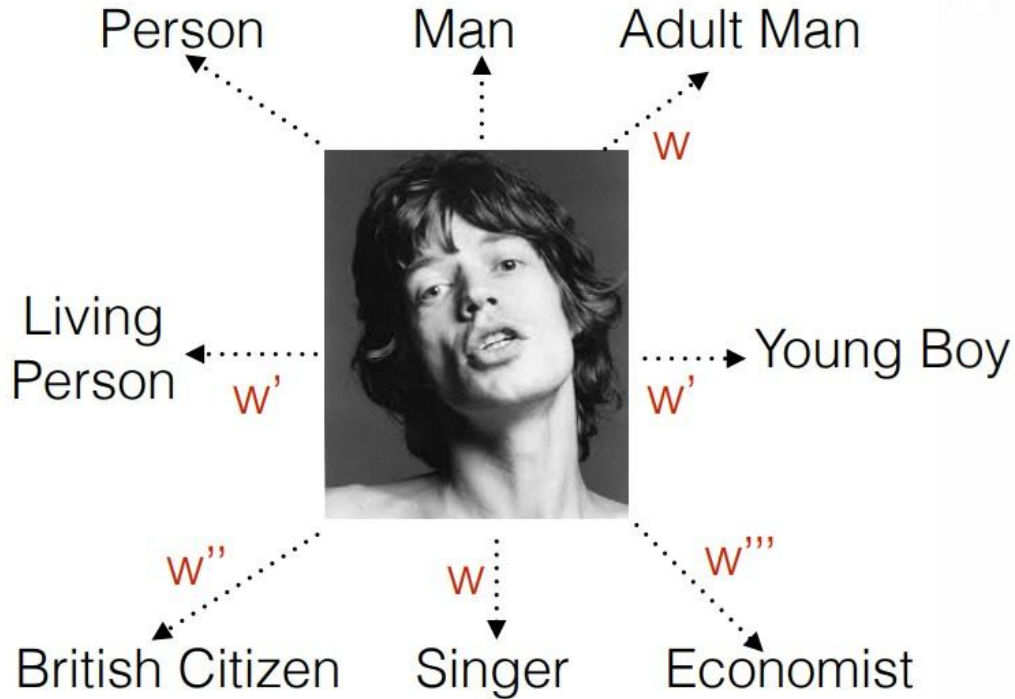
How to differentiate following endurants ?



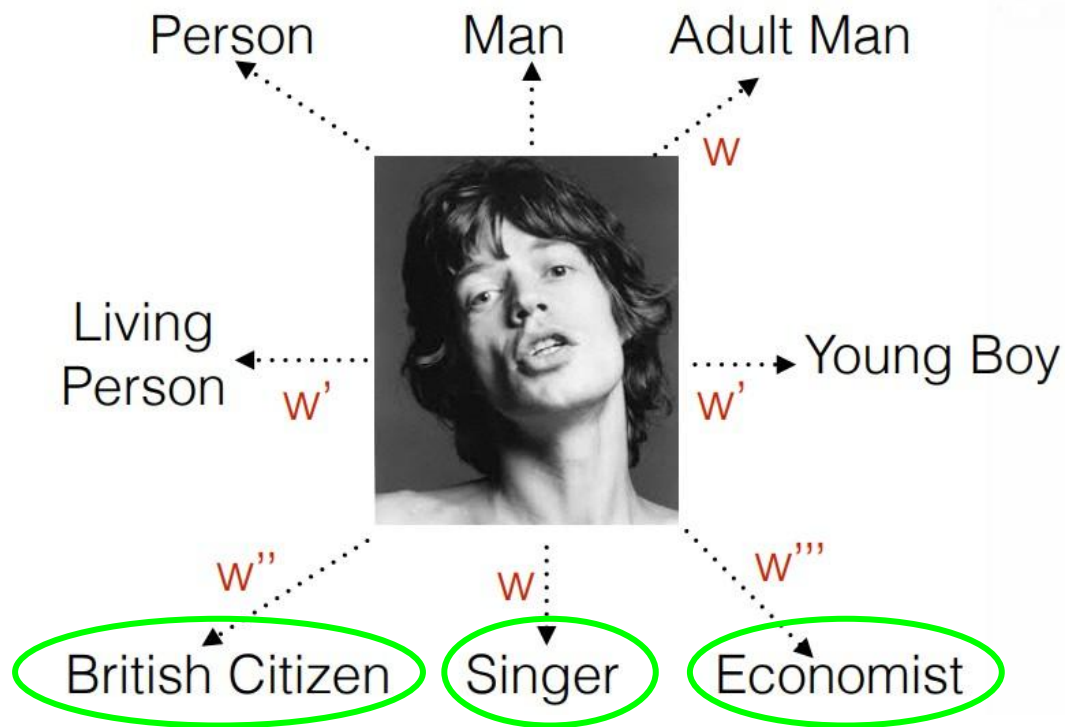
Identity (owner)



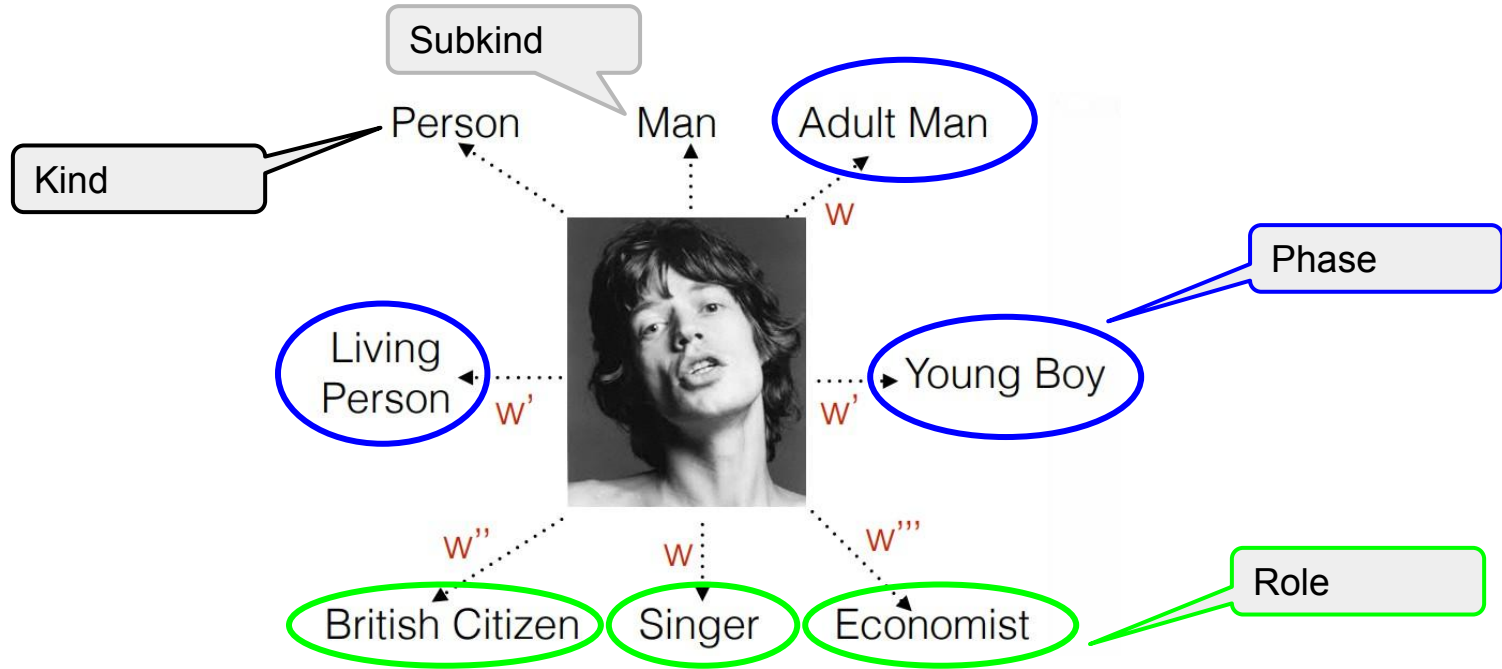
Rigidity



Relational dependance



Classification of the example



Meta-properties of endurant types

Let's T, T' be endurant types, R relation.

- Identity

$I^+(T)$ – carries identity

$O^+(T)$ – owns (supply) 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)

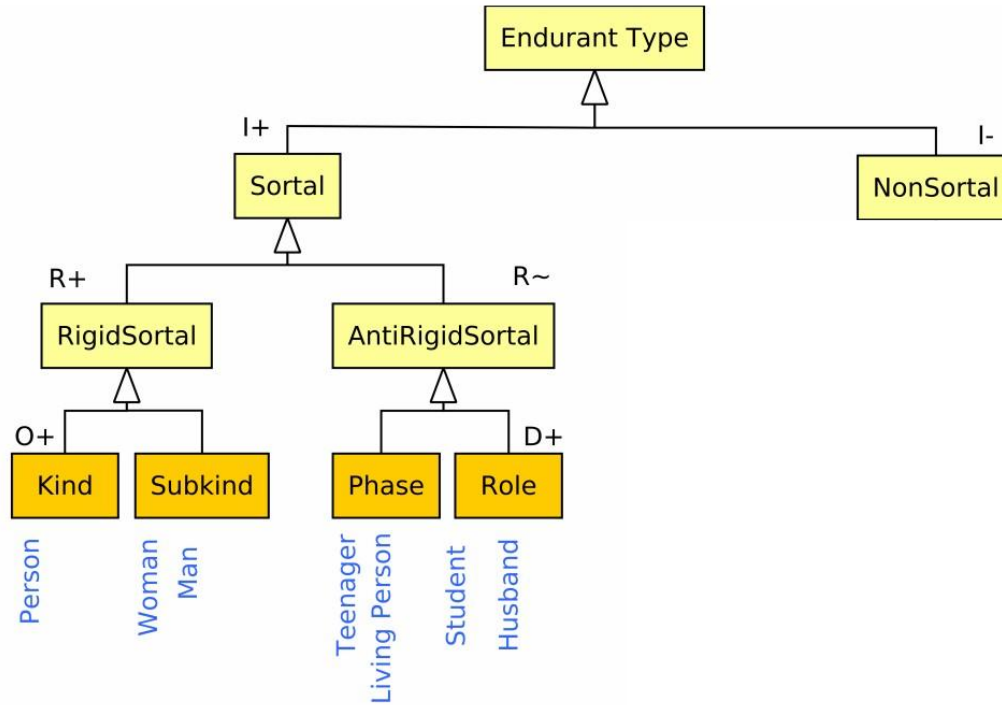
$R^\sim(T) = \Box(\forall x T(x) \rightarrow \Diamond(\neg T(x)))$ (Anti-Rigid)

$R^s(T) = R^-(T) \wedge \neg R^\sim(T)$ (Semi-Rigid)

- Relational Dependence

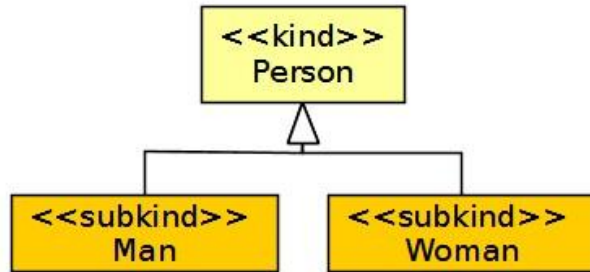
$D^+(T, T', R) =_{def} \Box(\forall x T(x) \rightarrow \exists y T'(y) \wedge R(x, y))$

Classification based on meta-properties

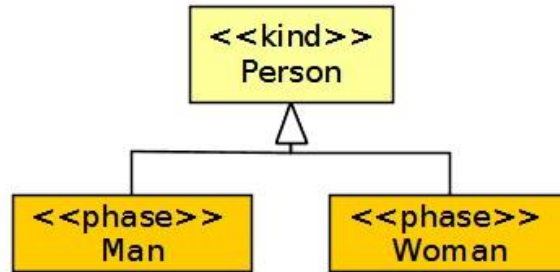


How to model Man/Woman concepts ?

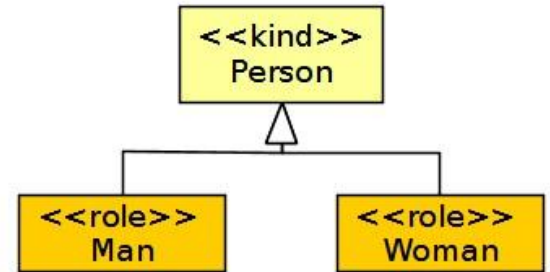
1.



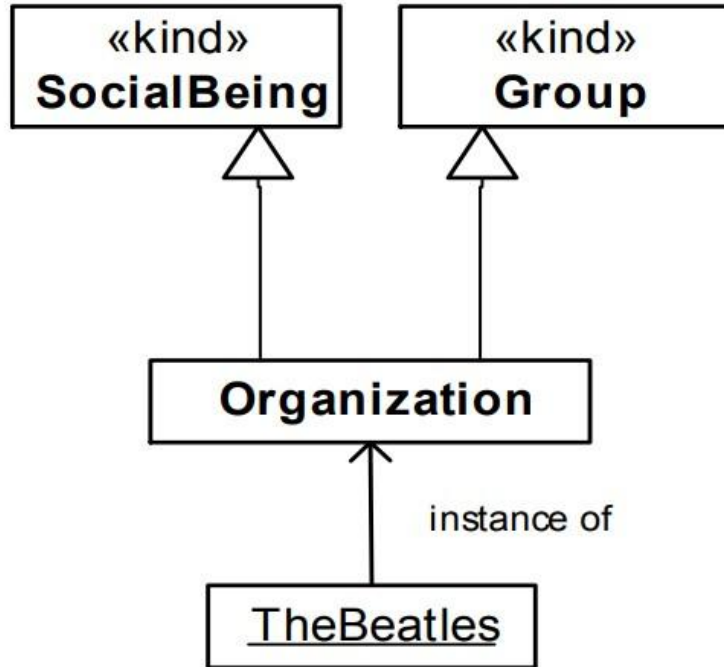
2.



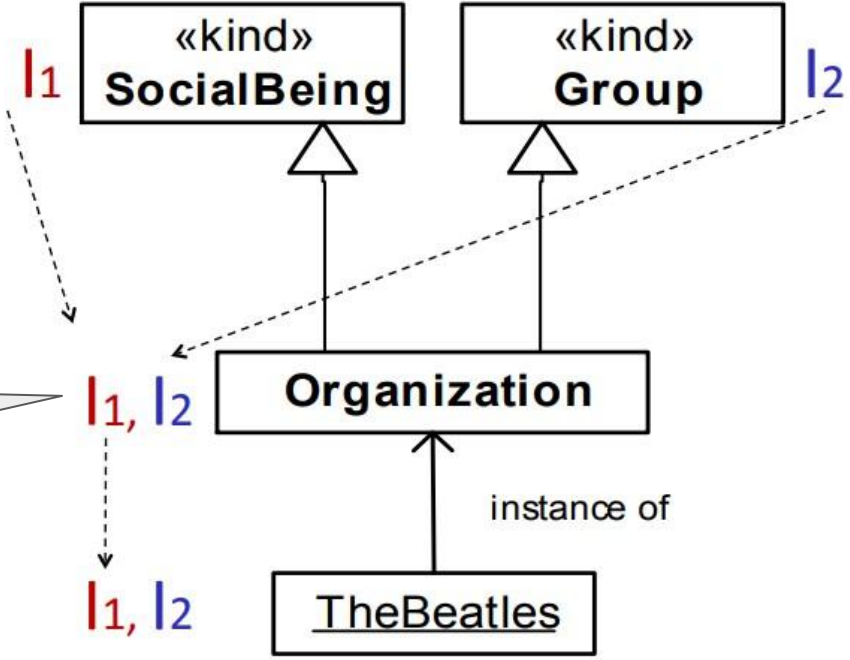
3.

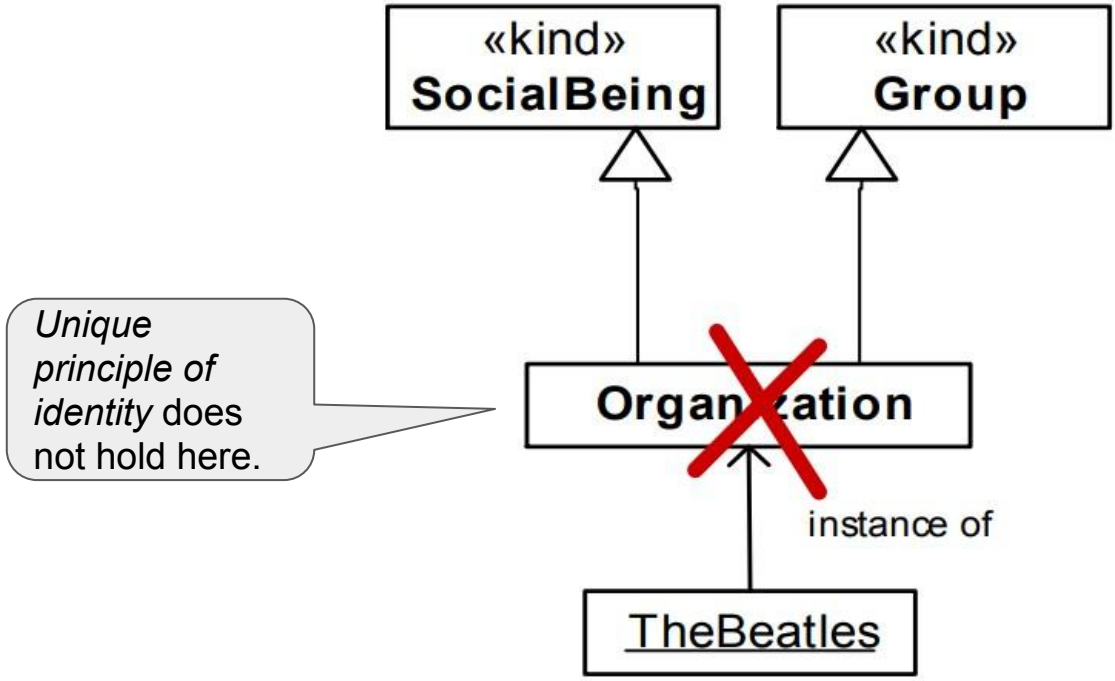


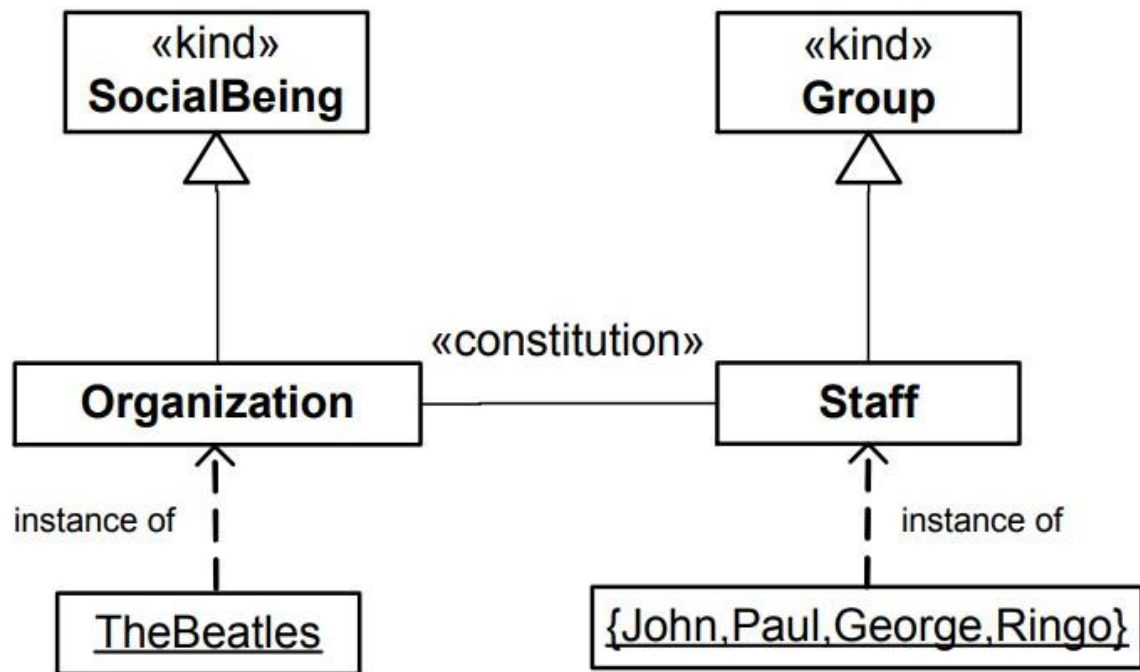
How to model The Beatles ?



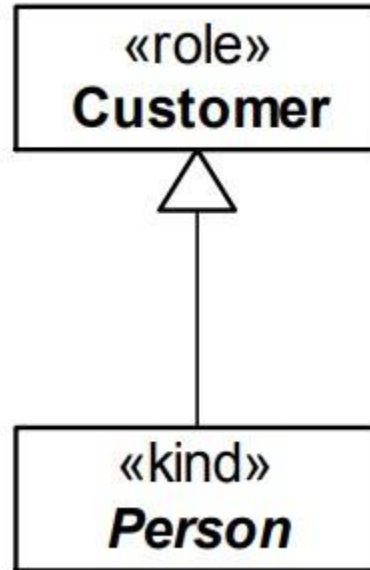
Principle of identity are not compatible.

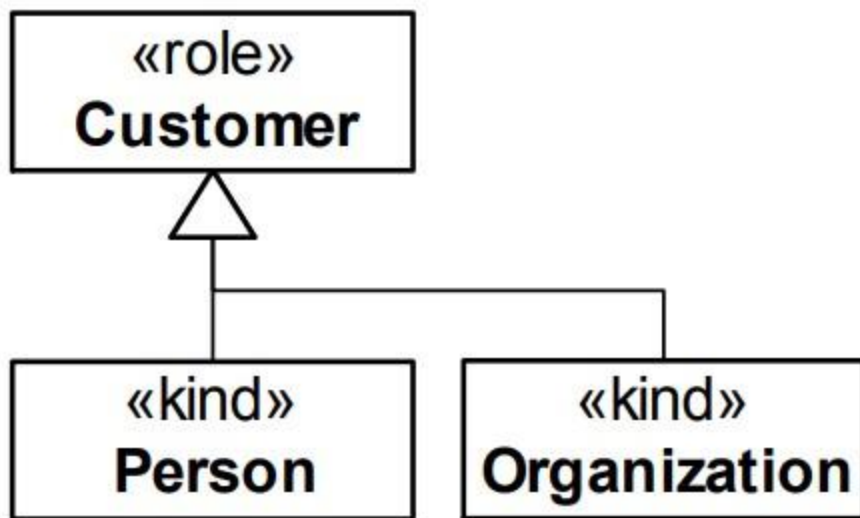




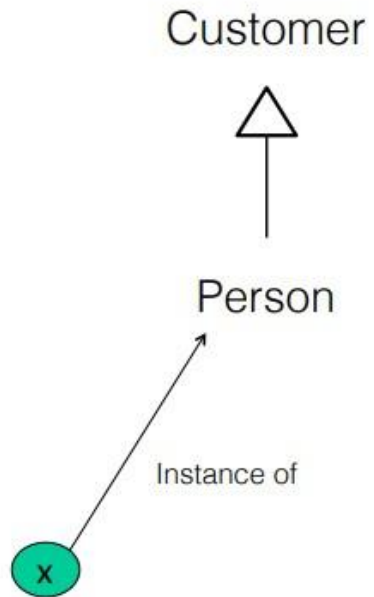


How to model Customer ?

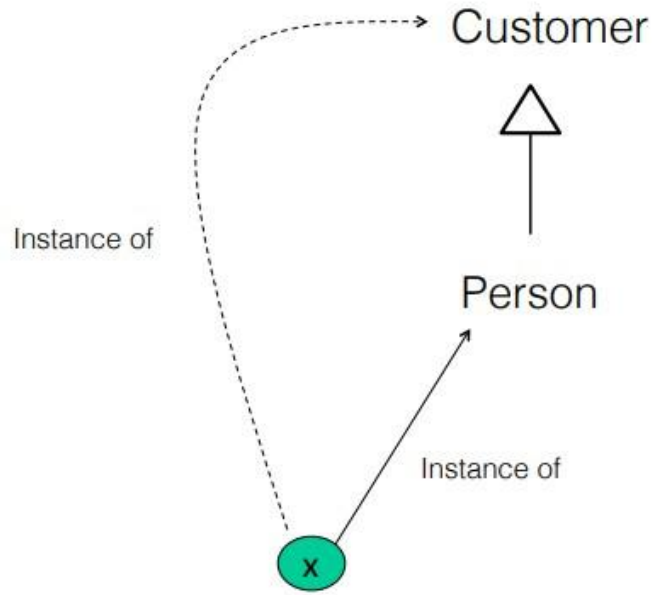




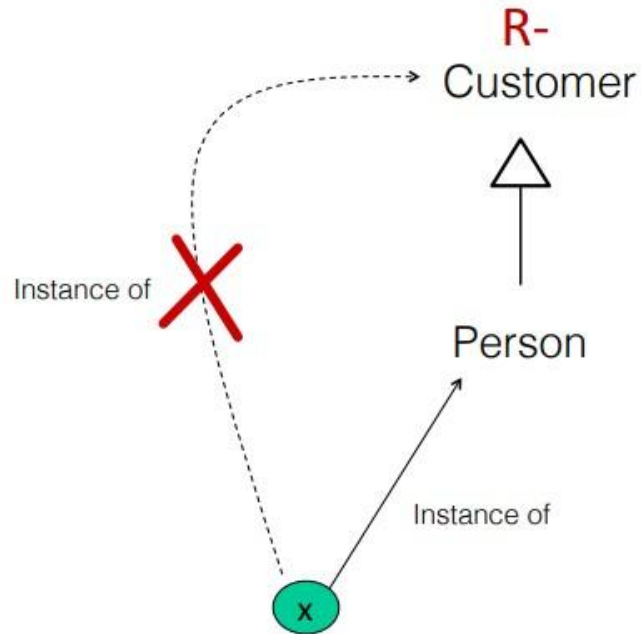
WORLD W



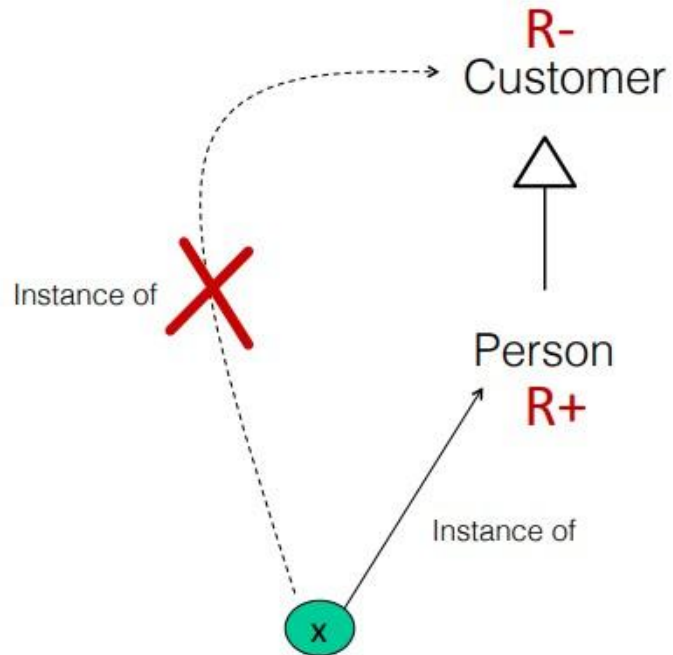
WORLD W



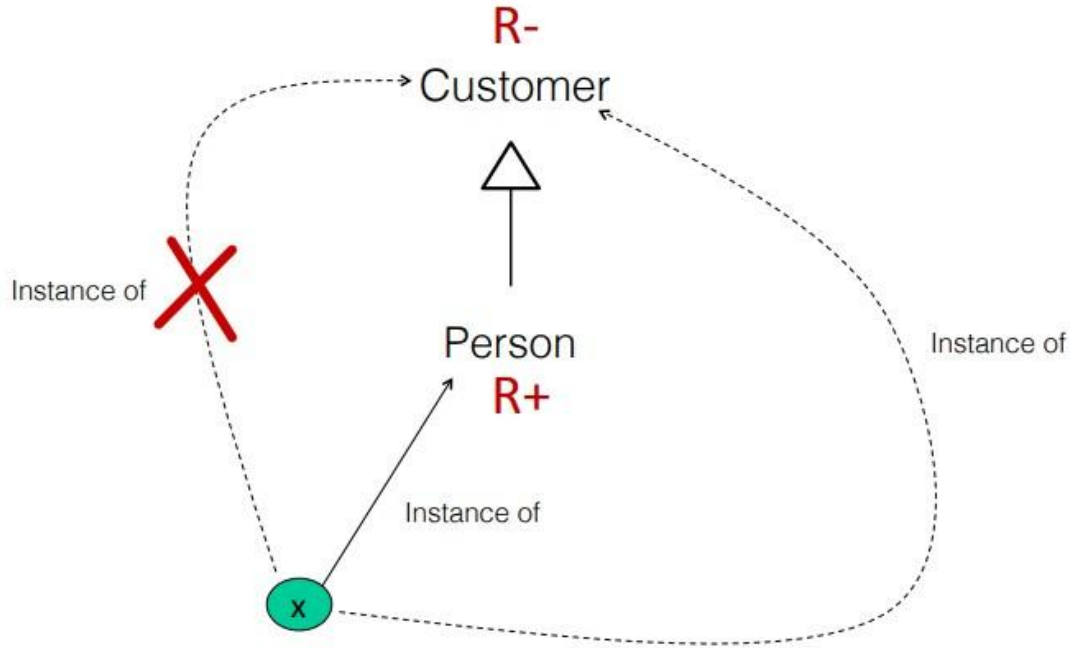
WORLD W'



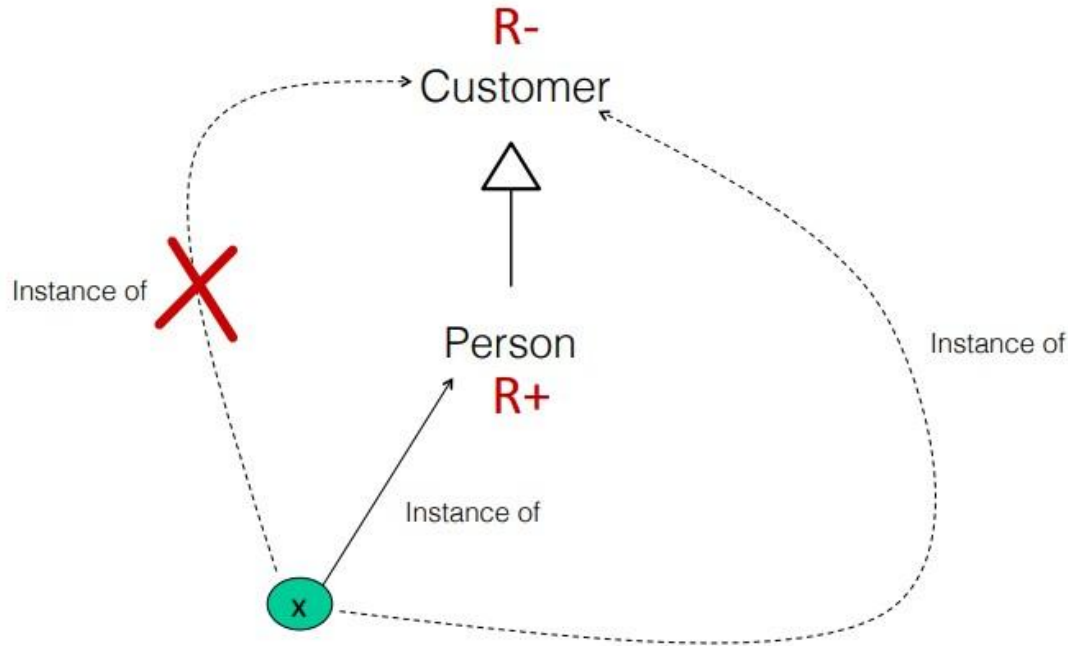
WORLD W'



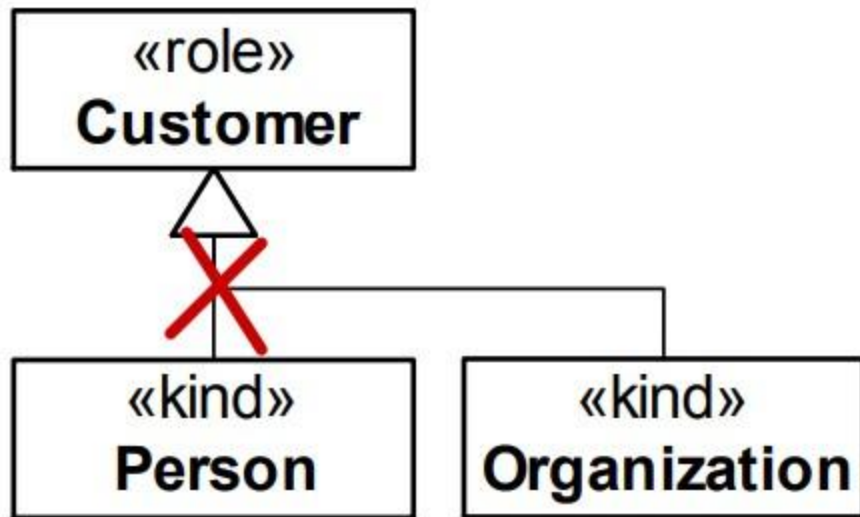
WORLD W'



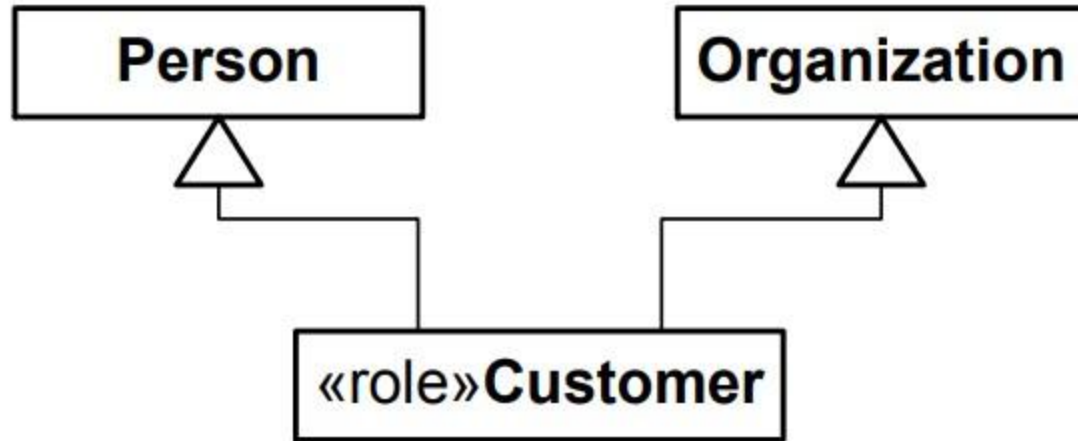
WORLD W'



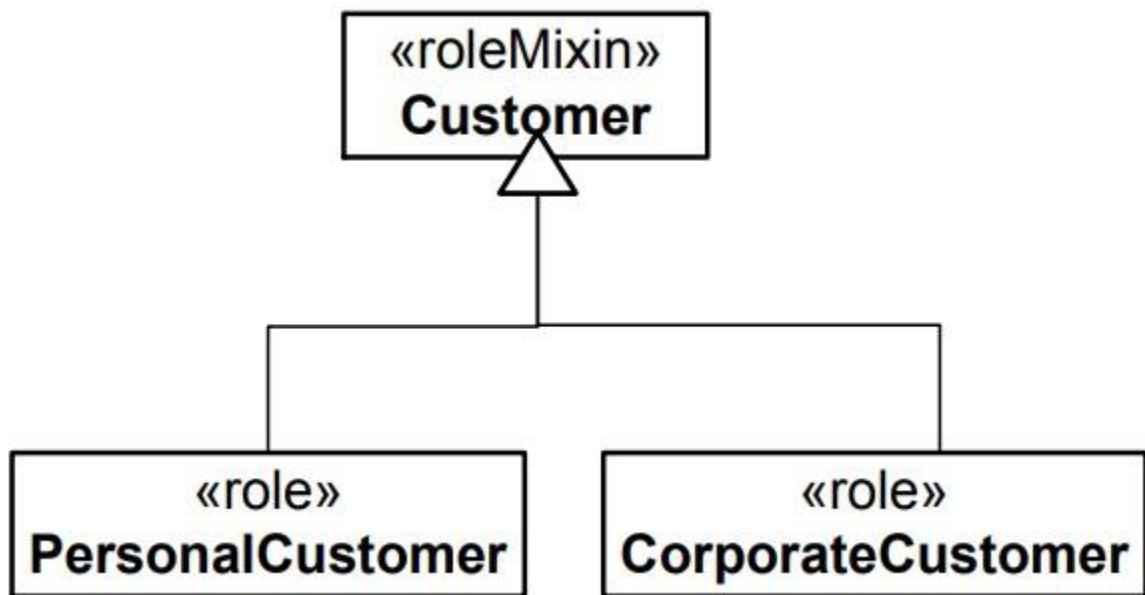
We run into a logical contradiction!

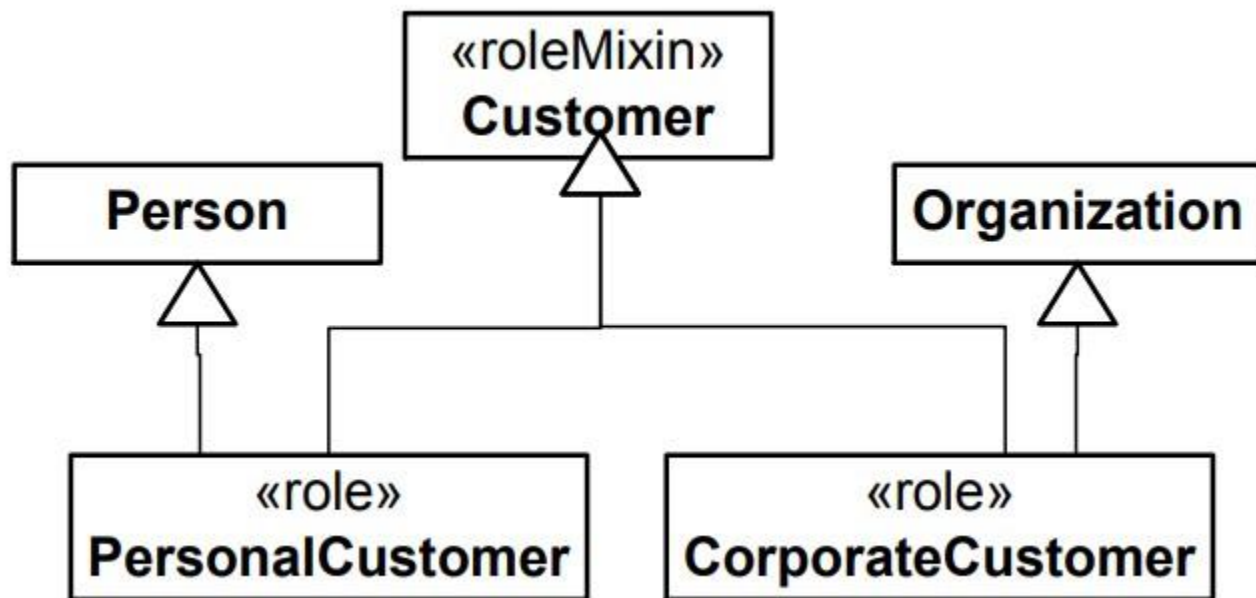


Any alternative ? Role with multiple allowed types ?

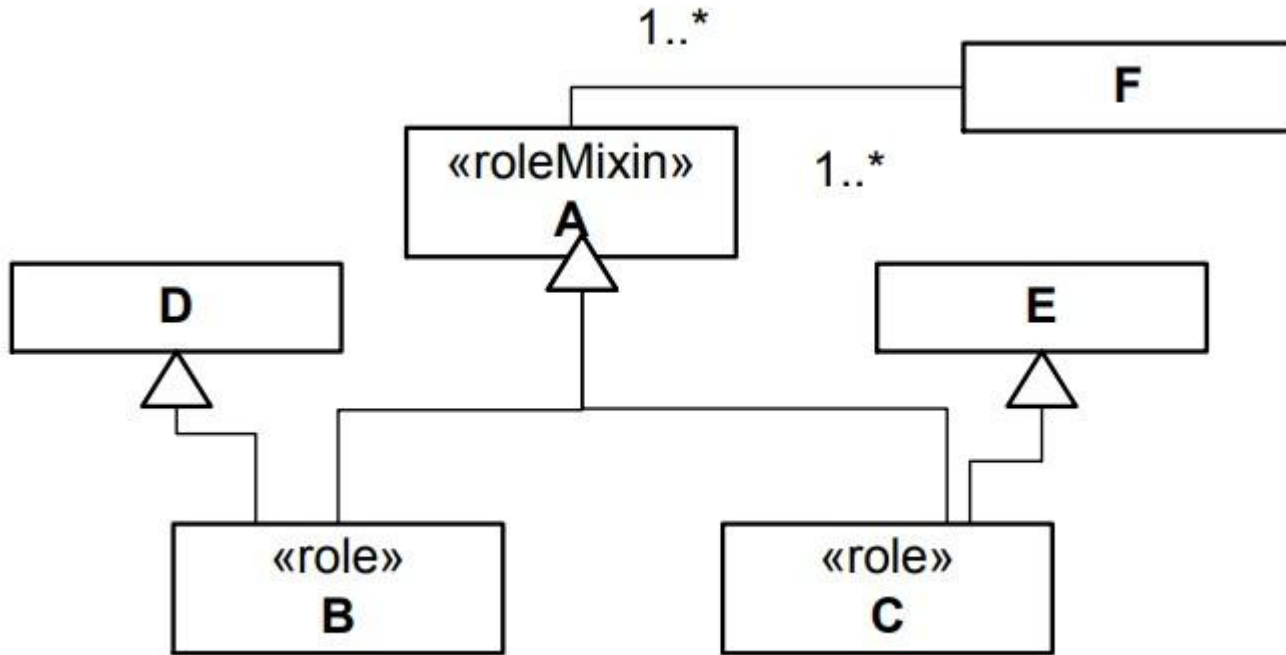


«roleMixin»
Customer

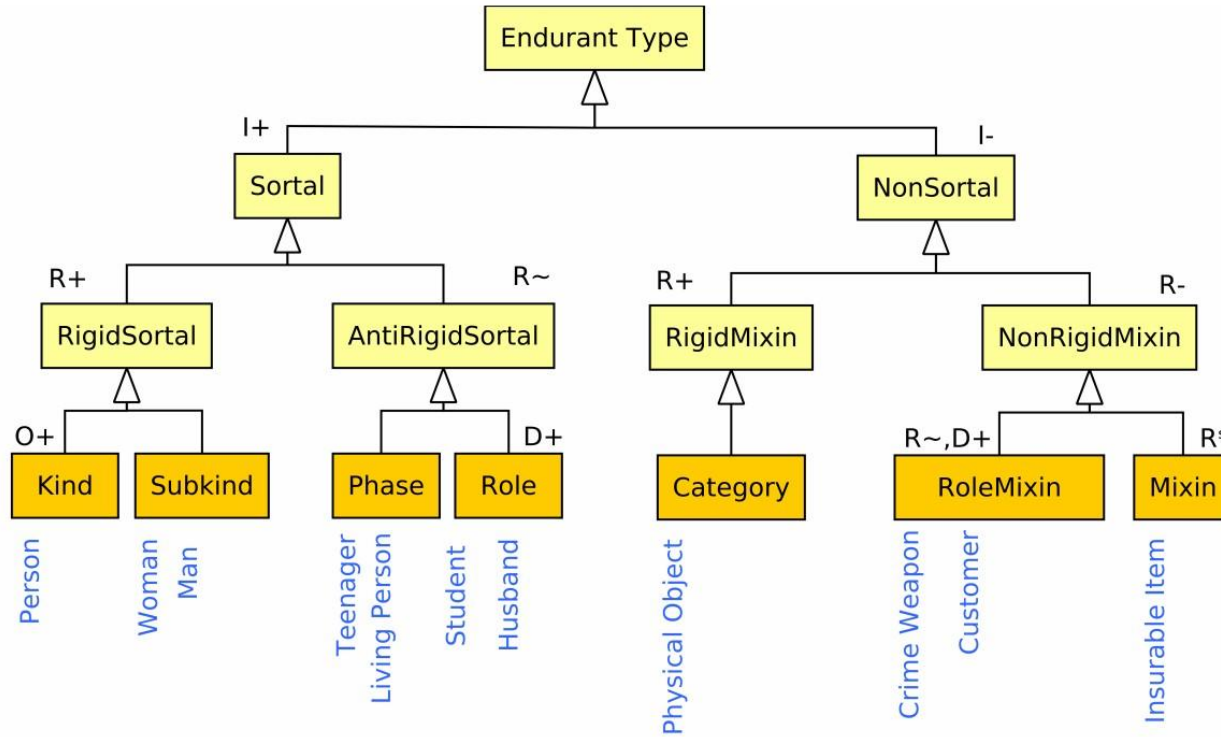




RoleMixin pattern



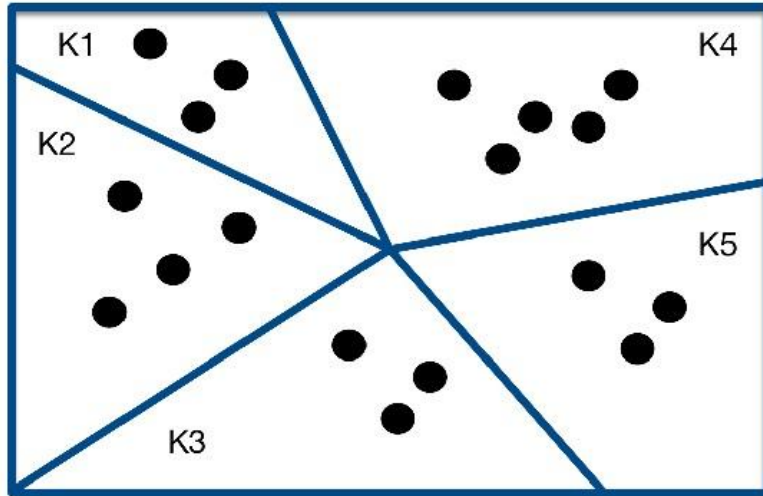
Classification based on meta-properties



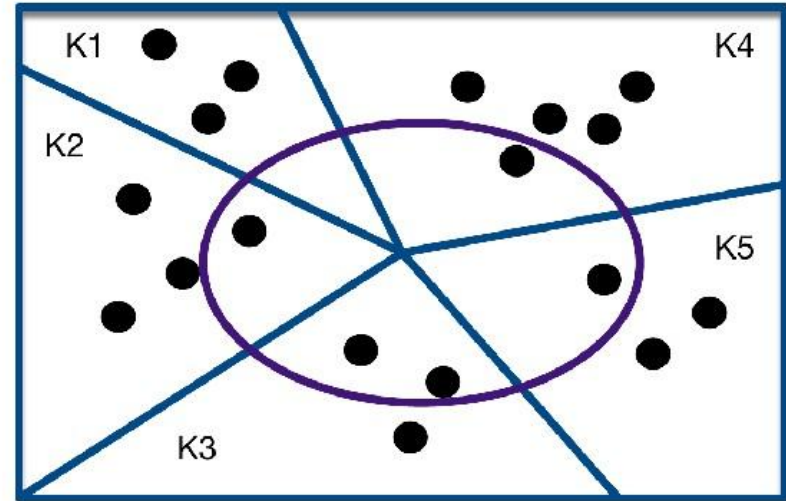
What possible restrictions for sub-typing exist ?

Rigid endurant types

Kinds

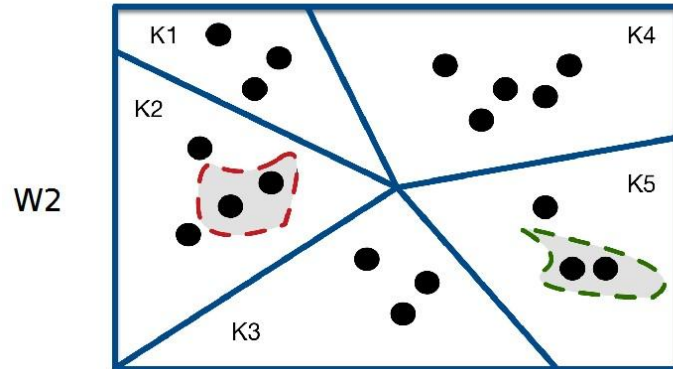
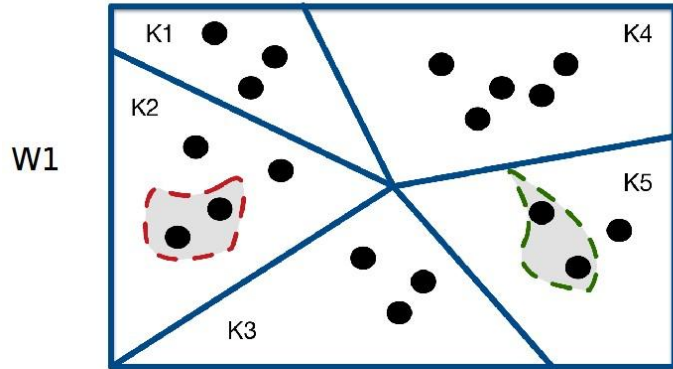


Rigid Mixins

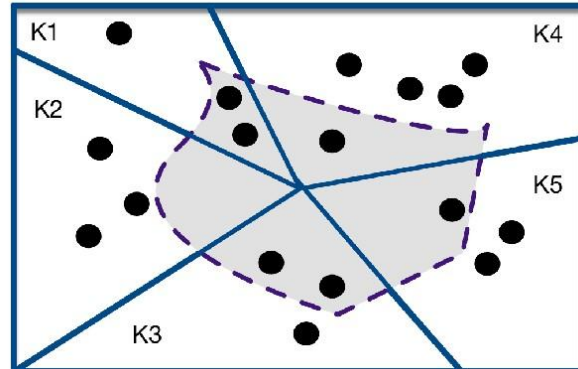
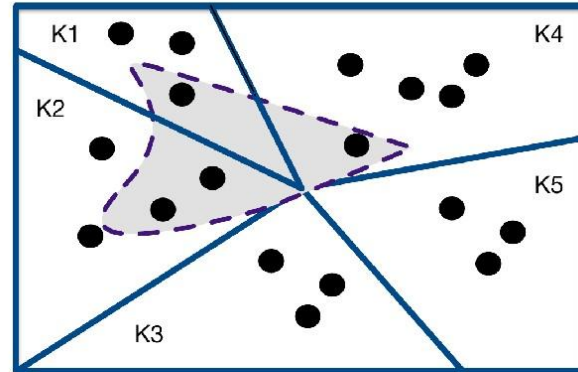


Anti-rigid endurant types

Anti-Rigid Sortals (Phase, Role)

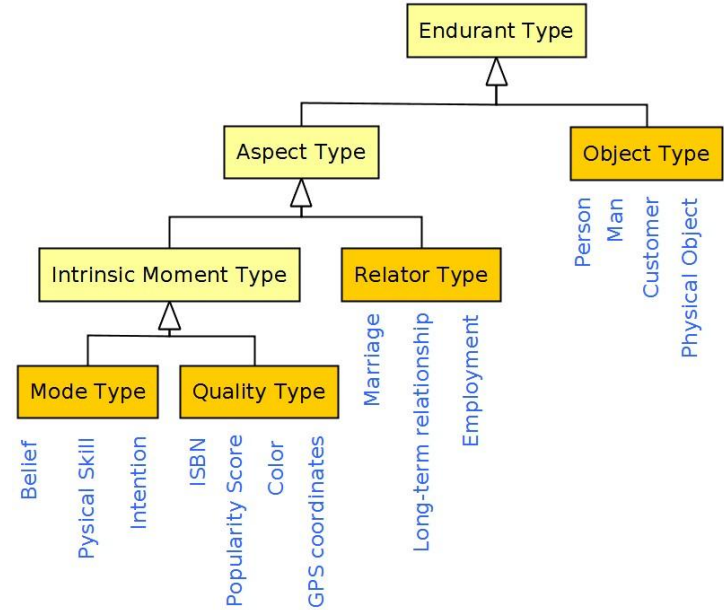
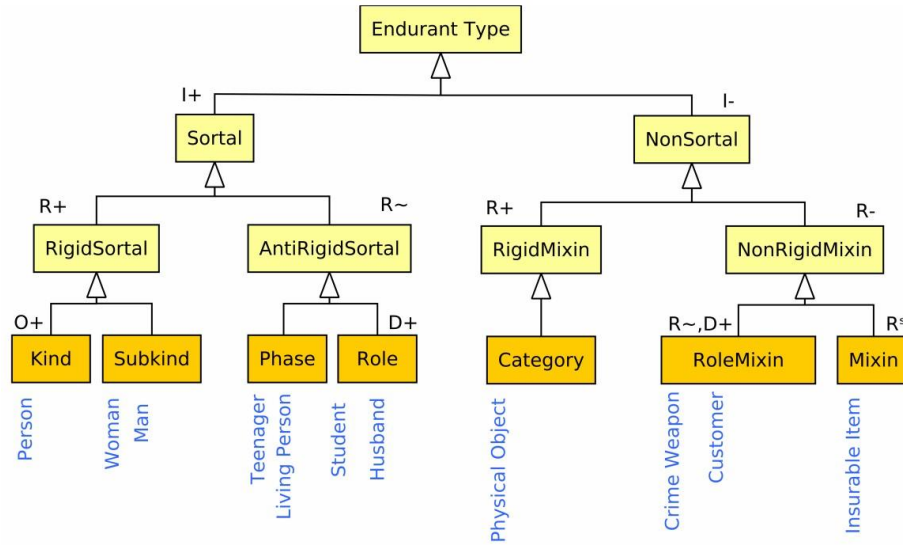


Anti-Rigid Mixins

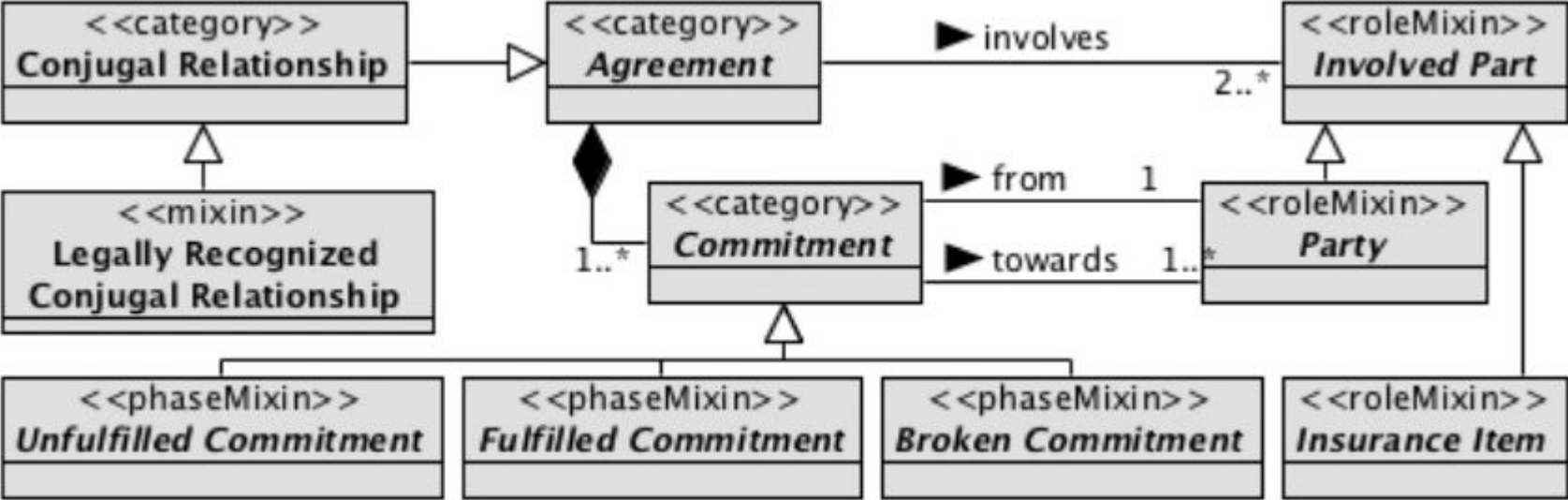


Summary

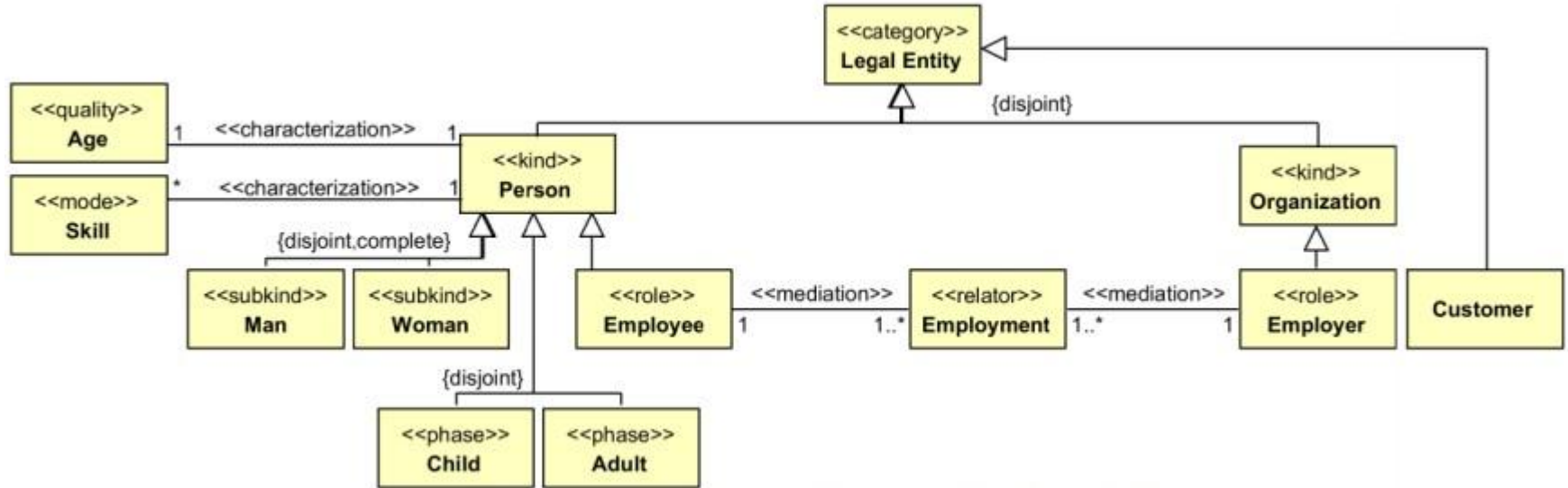
(meta-property vs. ontology nature based classification)



Examples of non-sortal universals

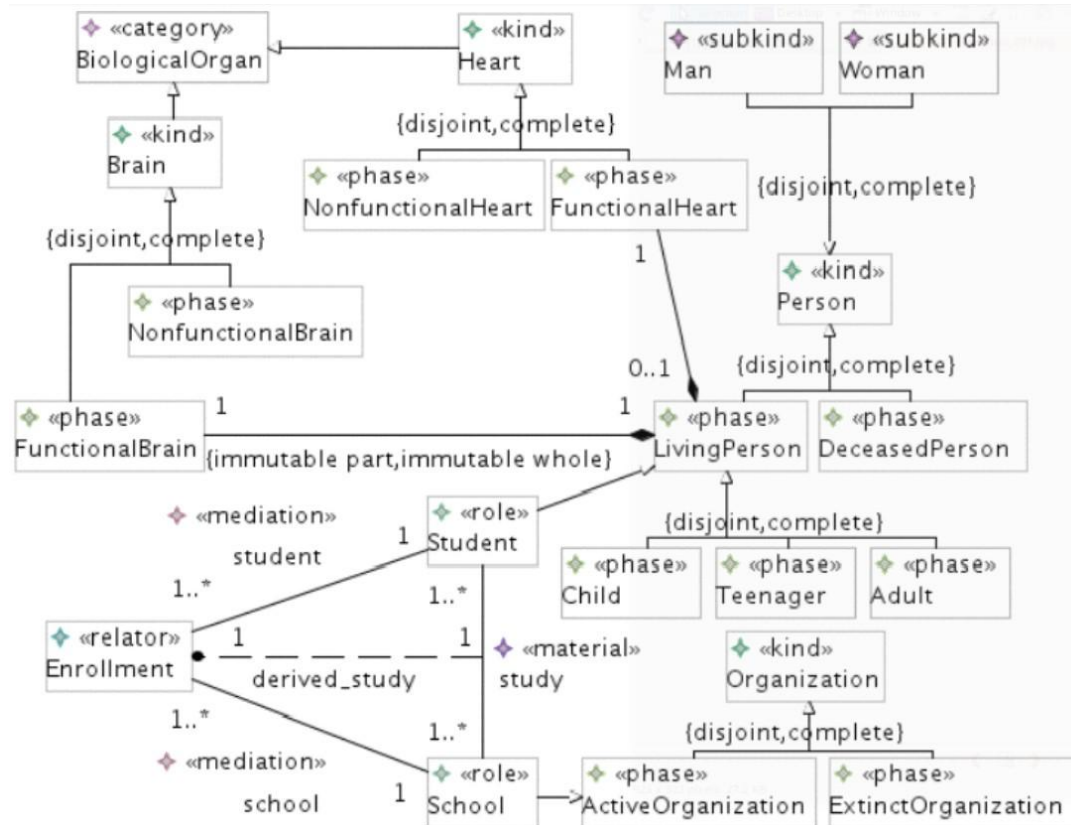


OntoUML example (1/2)



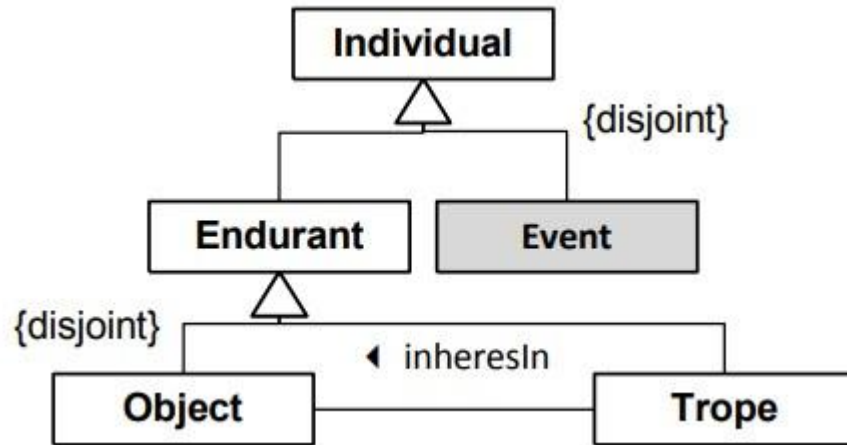
An example of UFO based model in OntoUML taken from [carvalho2017multi].

OntoUML example (2/2)

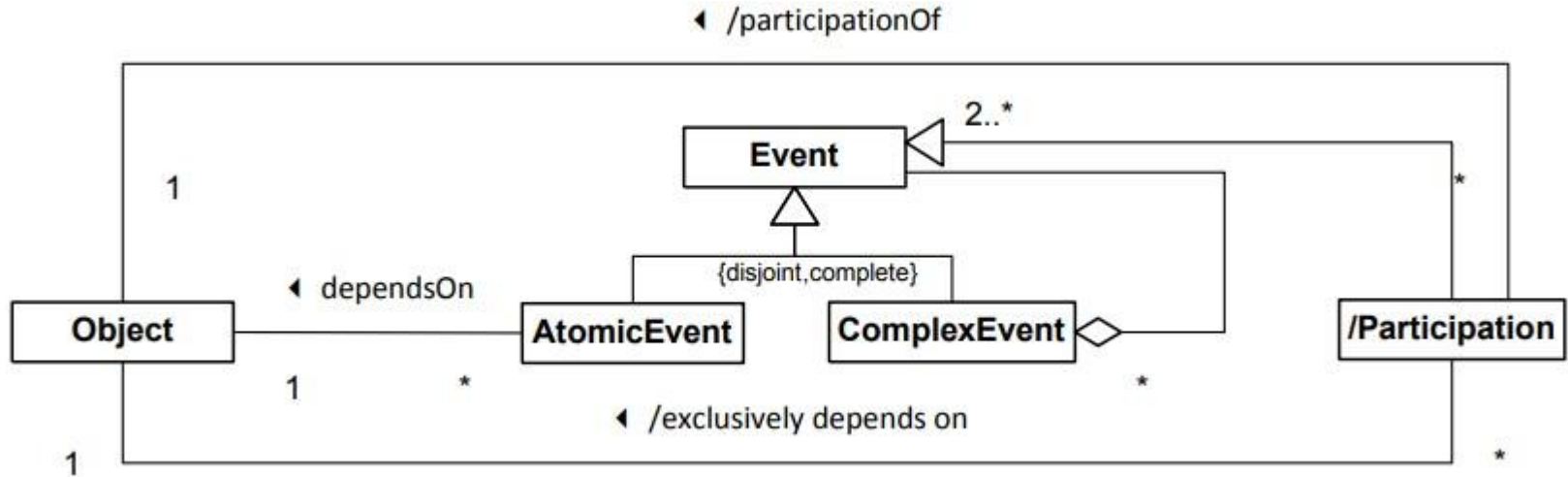


UFO-B

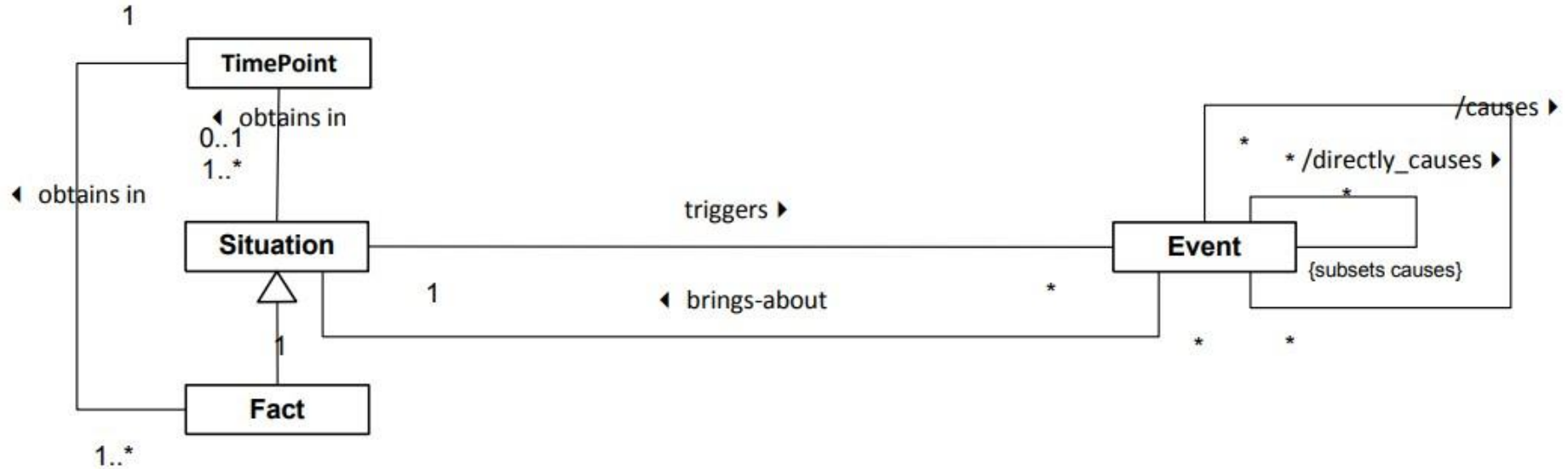
Small UFO Fragment with Events



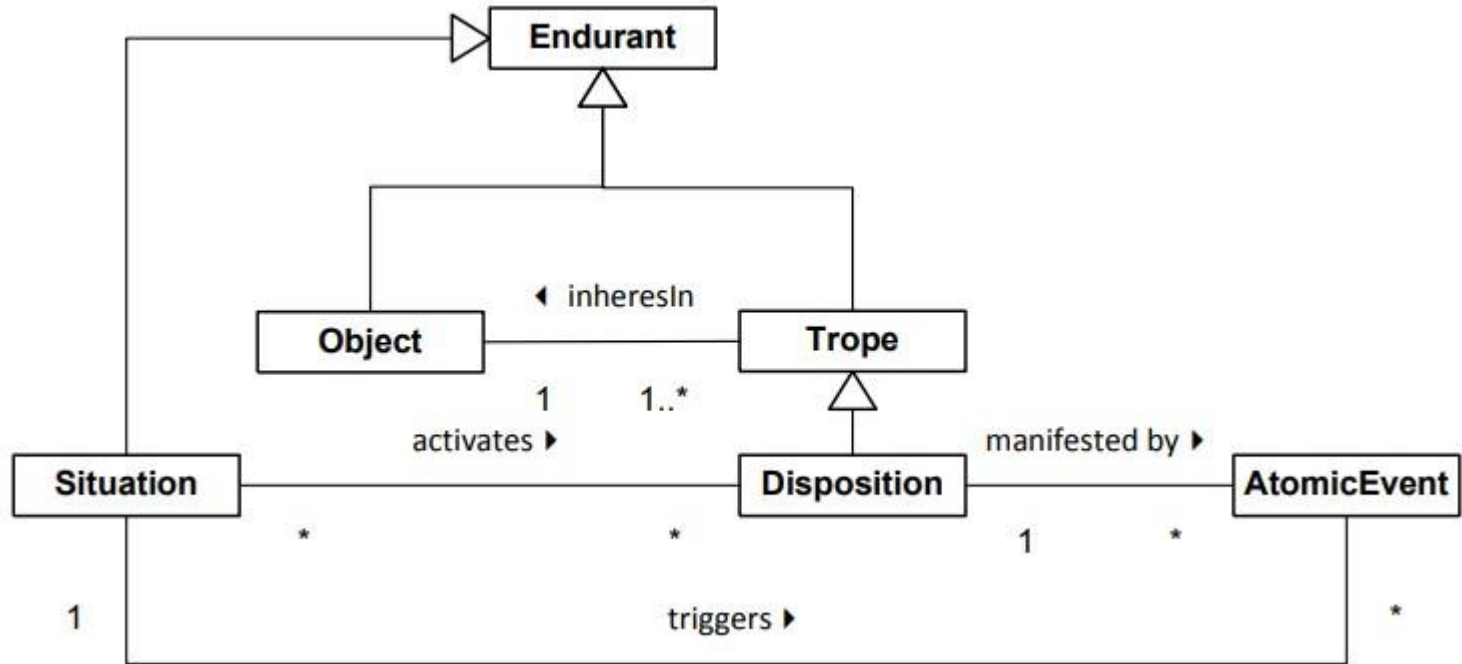
Complex Events as Sums of Object's Participations



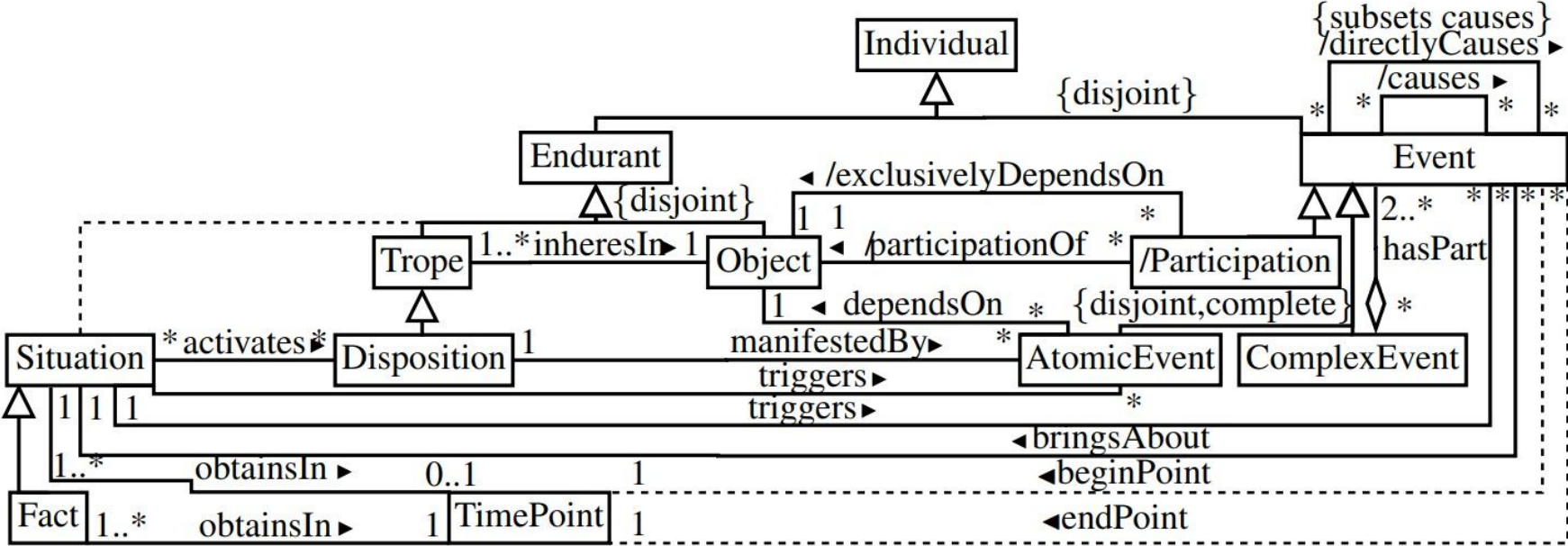
Situations, Events as Changes



Atomic Events as Manifestations of Object Dispositions



Detailed model



Example

