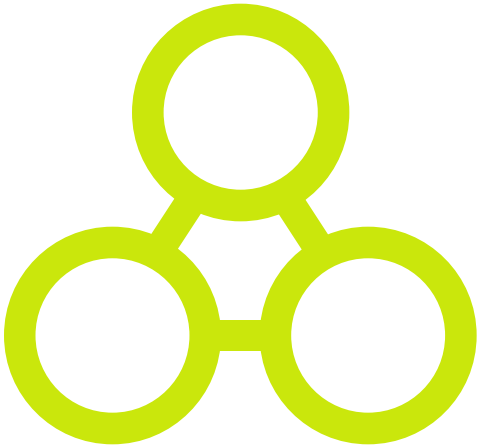
Formal Ontology. (Anti-)Patterns and Model Simulation

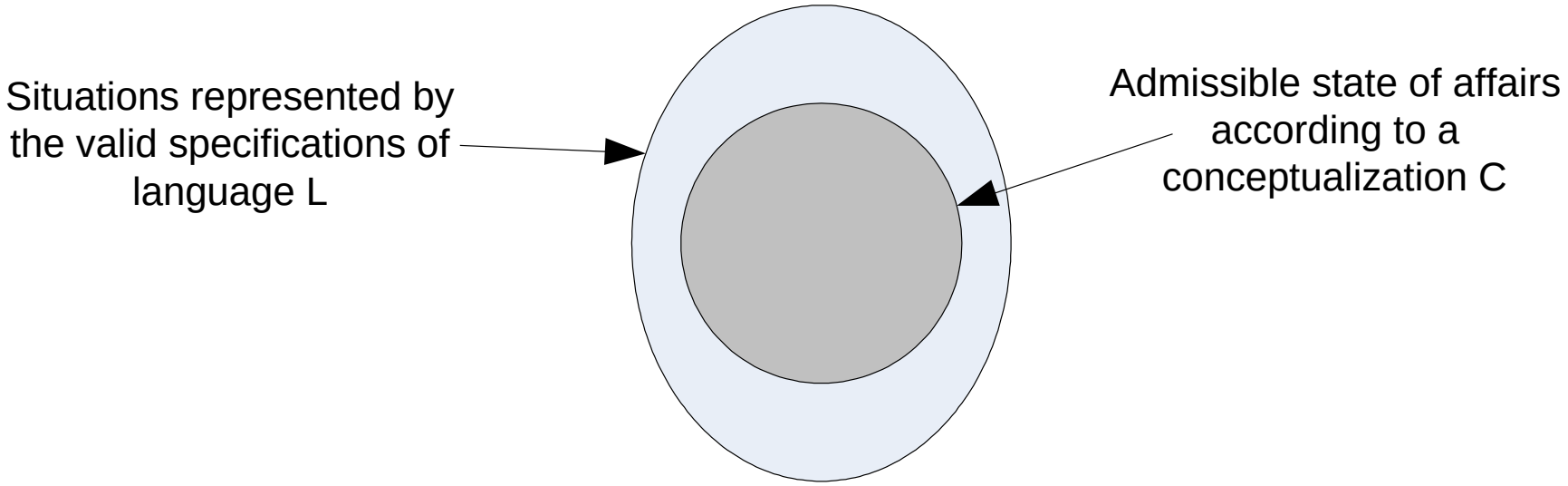


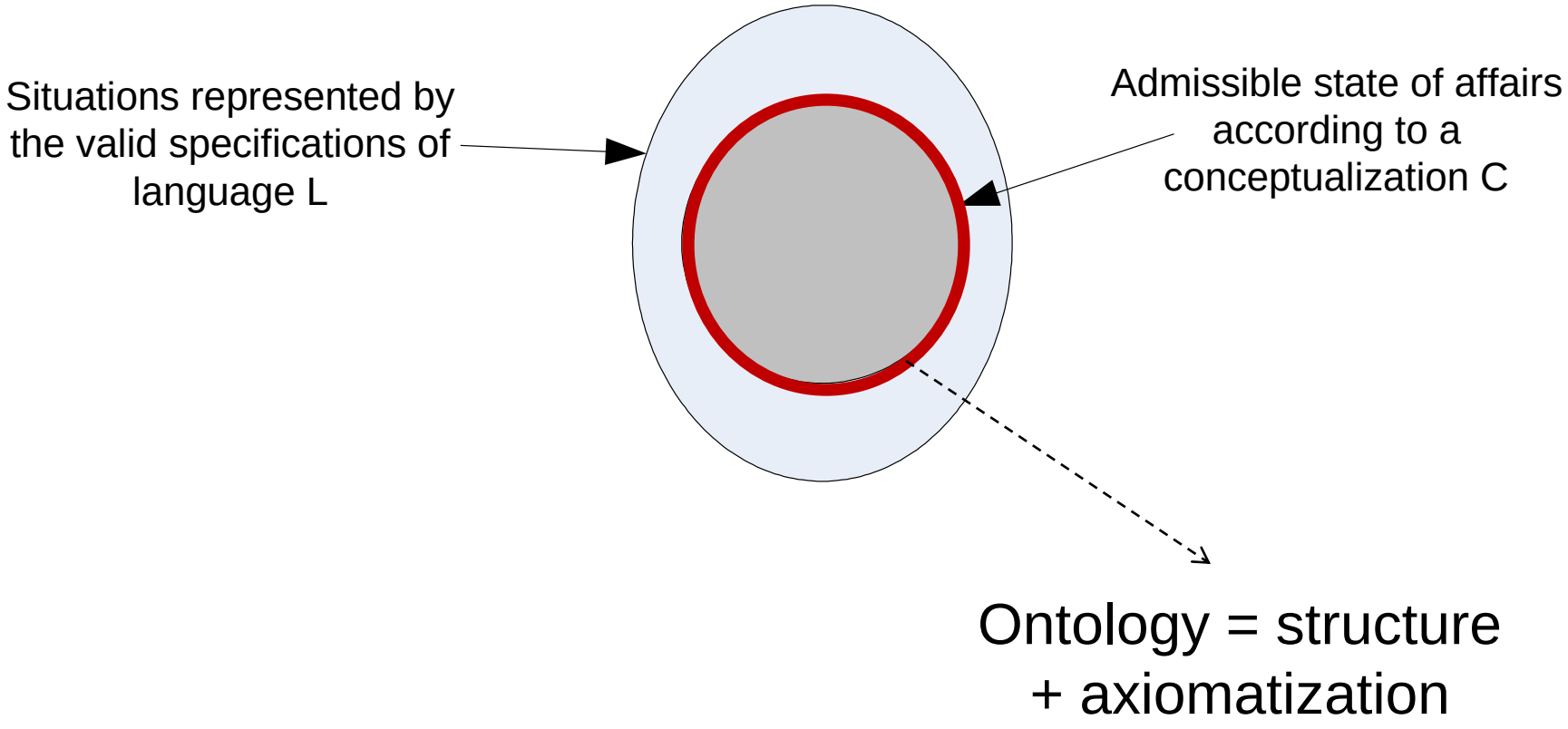
nemo

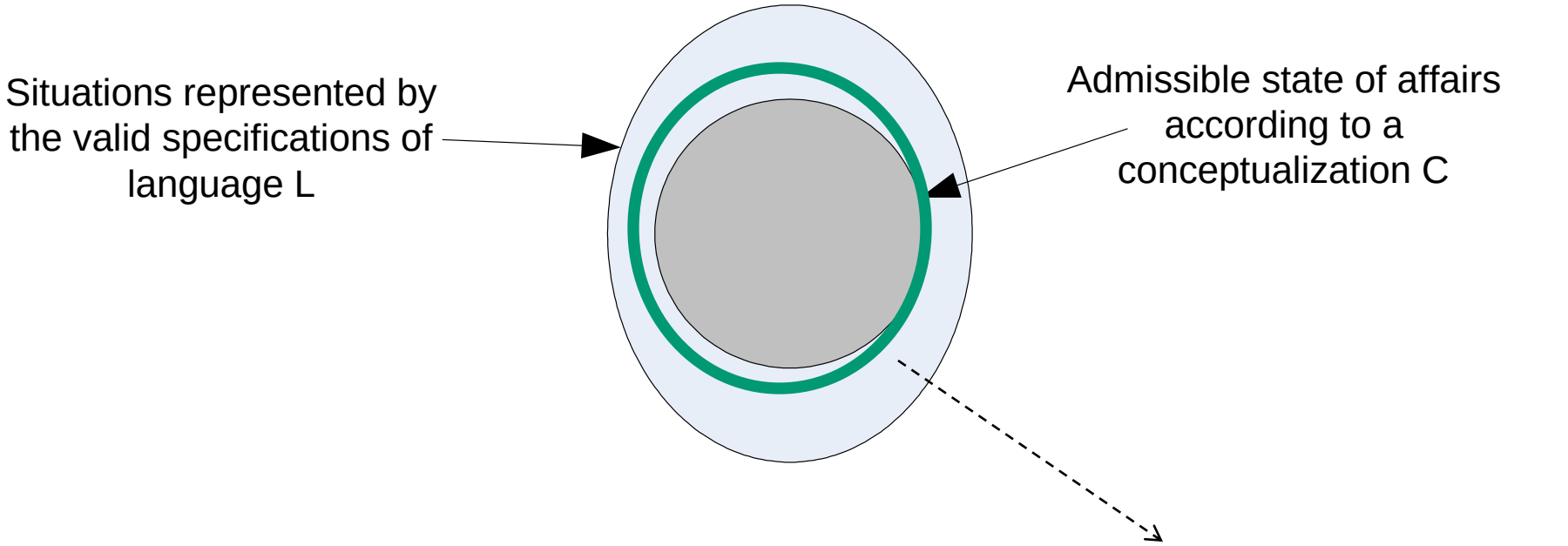
ontology & conceptual modeling research group

Giancarlo Guizzardi
Computer Science Department
Federal University of Espírito Santo (UFES), Brazil

ONTOLOG 2012
Earth Science Ontology Dialog


Situations represented by the valid specifications of language L
Admissible state of affairs according to a conceptualization C


Situations represented by the valid specifications of language L
Admissible state of affairs according to a conceptualization C
Ontology = structure + axiomatization



Ontology = structure
+ domain independent axioms

Formal Ontology

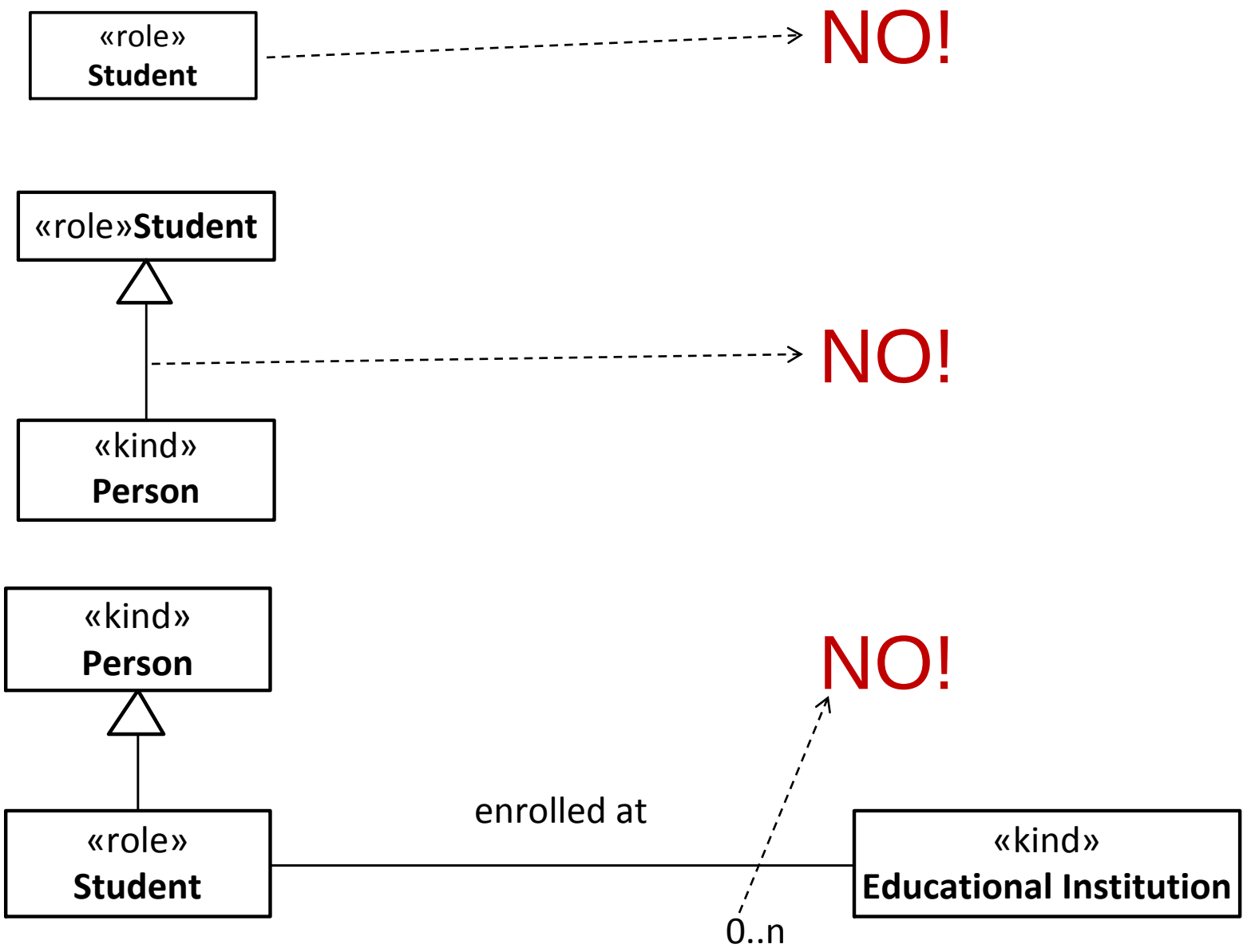
A discipline that deals with formal ontological structures (e.g. theory of parts, theory of wholes, types and instantiation, identity, dependence, unity) which apply to all material domains in reality.

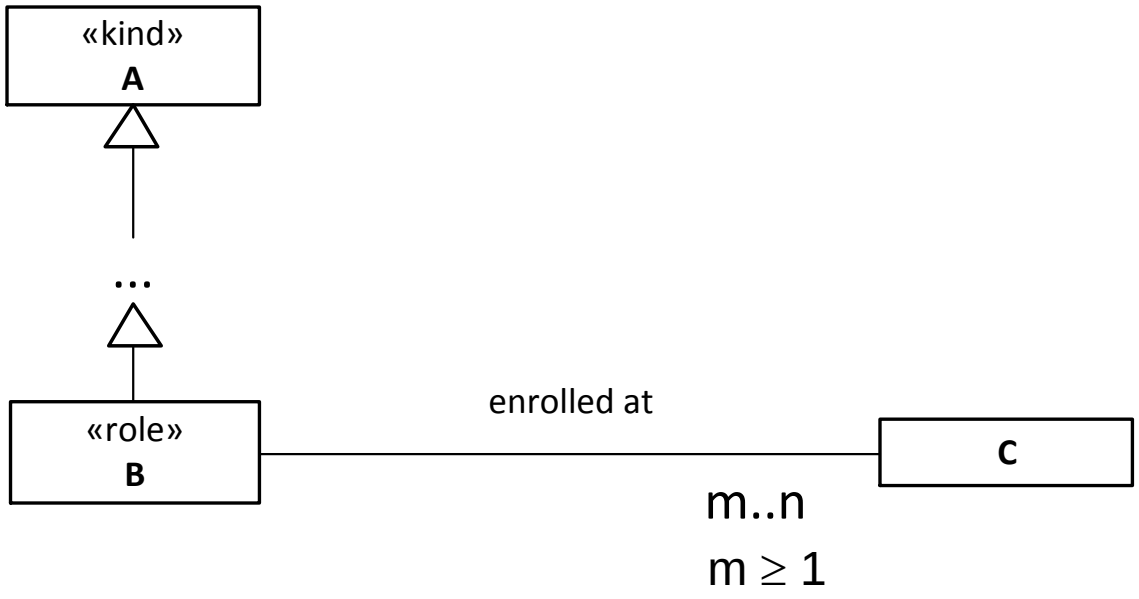
Ontological Distinctions among Types

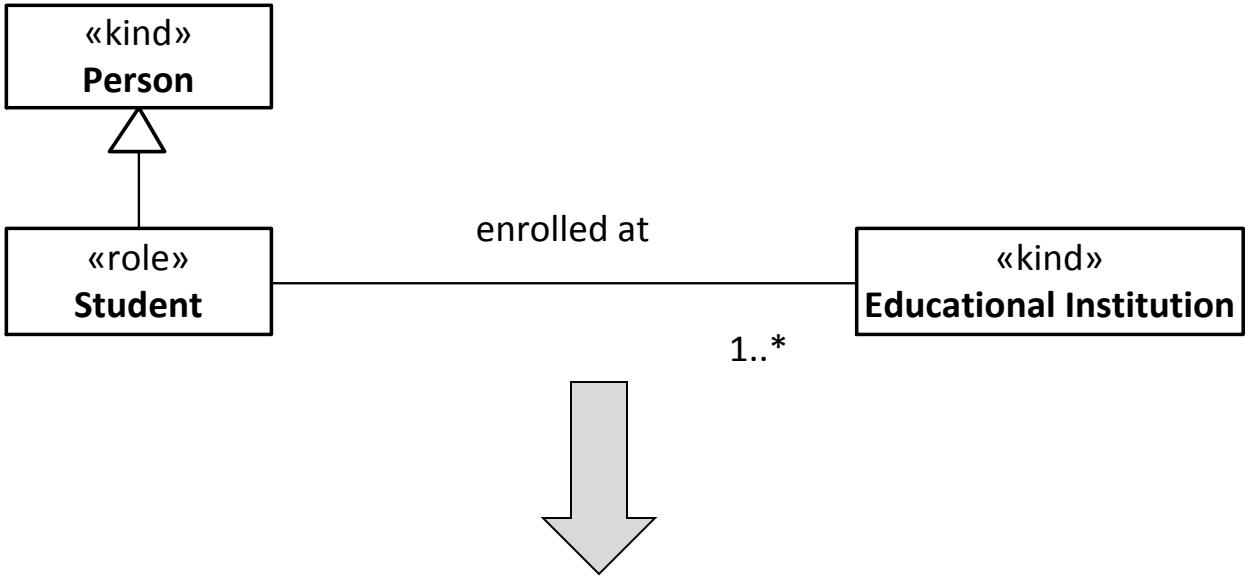
KIND: Every instance of a KIND is necessarily an instance of that KIND (e.g., Person)

ROLE (e.g., Student):

- All instances of a given ROLE are of the same KIND (e.g., all Students are Person)
- All instances of a ROLE intantiate that type only contingently (e.g., no Student is necessarily a Student)
- Instances of a KIND instantiate that ROLE when participating in a certain RELATIONAL CONTEXT (e.g., instances of Person instantiate the Role Student when enrolled in na Educational Institution)


«role»
Student
NO!
«role»Student
NO!
«kind»
Person
«kind»
Person
NO!
«role»
Student
enrolled at
«kind»
Educational Institution
0..n


«kind»
A
...
«role»
B
enrolled at
C
m..n
m ≥ 1



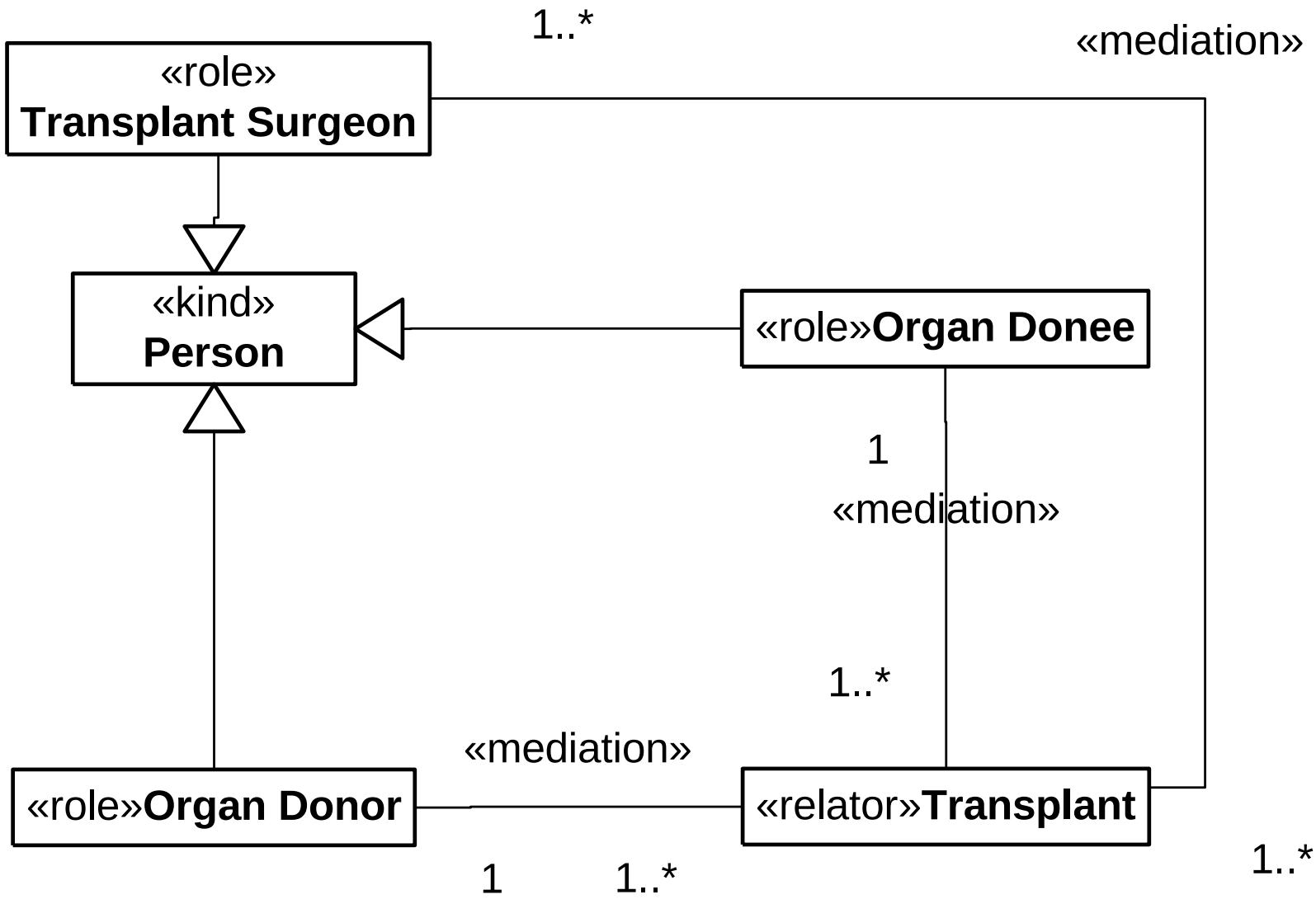
$\Box(\forall x\ \text{Person}(x) \rightarrow \Box(\text{Person}(x)))$

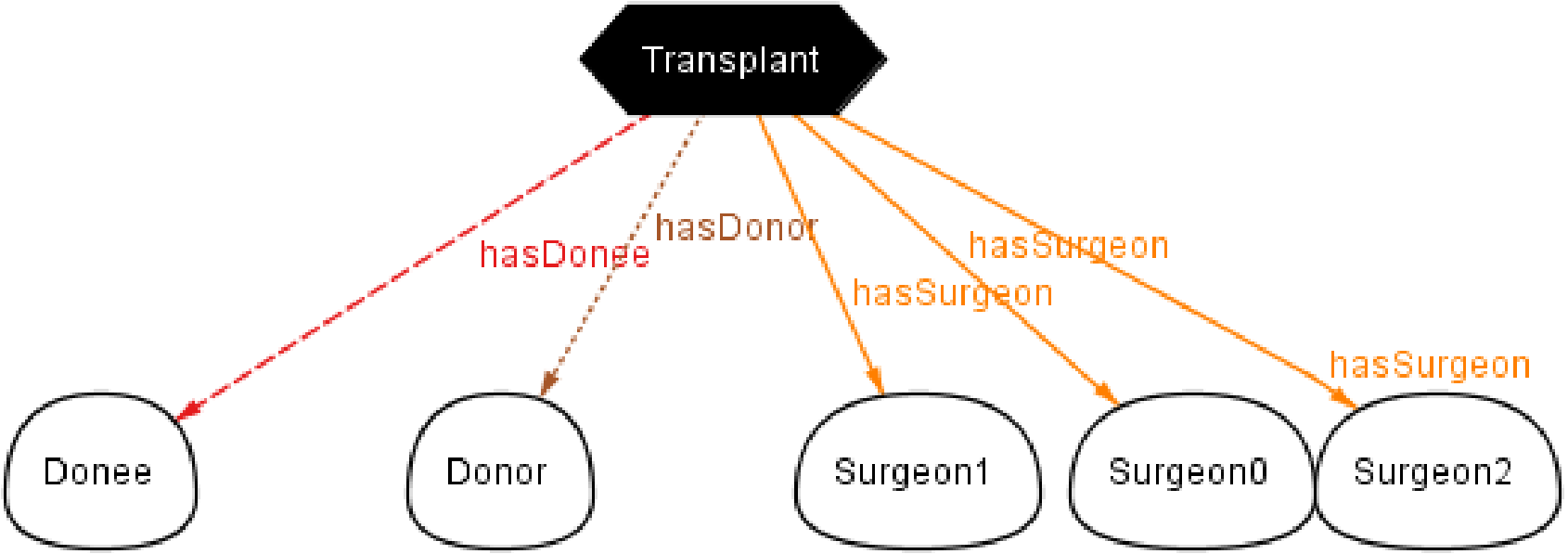
$\Box(\forall x\ \text{Student}(x) \rightarrow \Diamond(\neg\text{Student}(x)))$

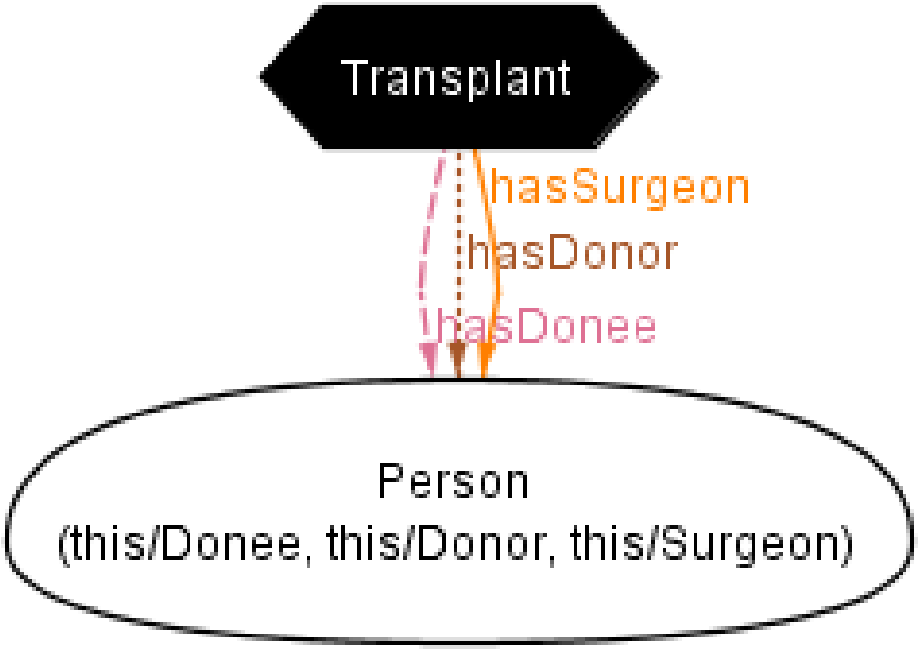
$\Box(\forall x\ \text{Student}(x) \rightarrow \text{Person}(x))$

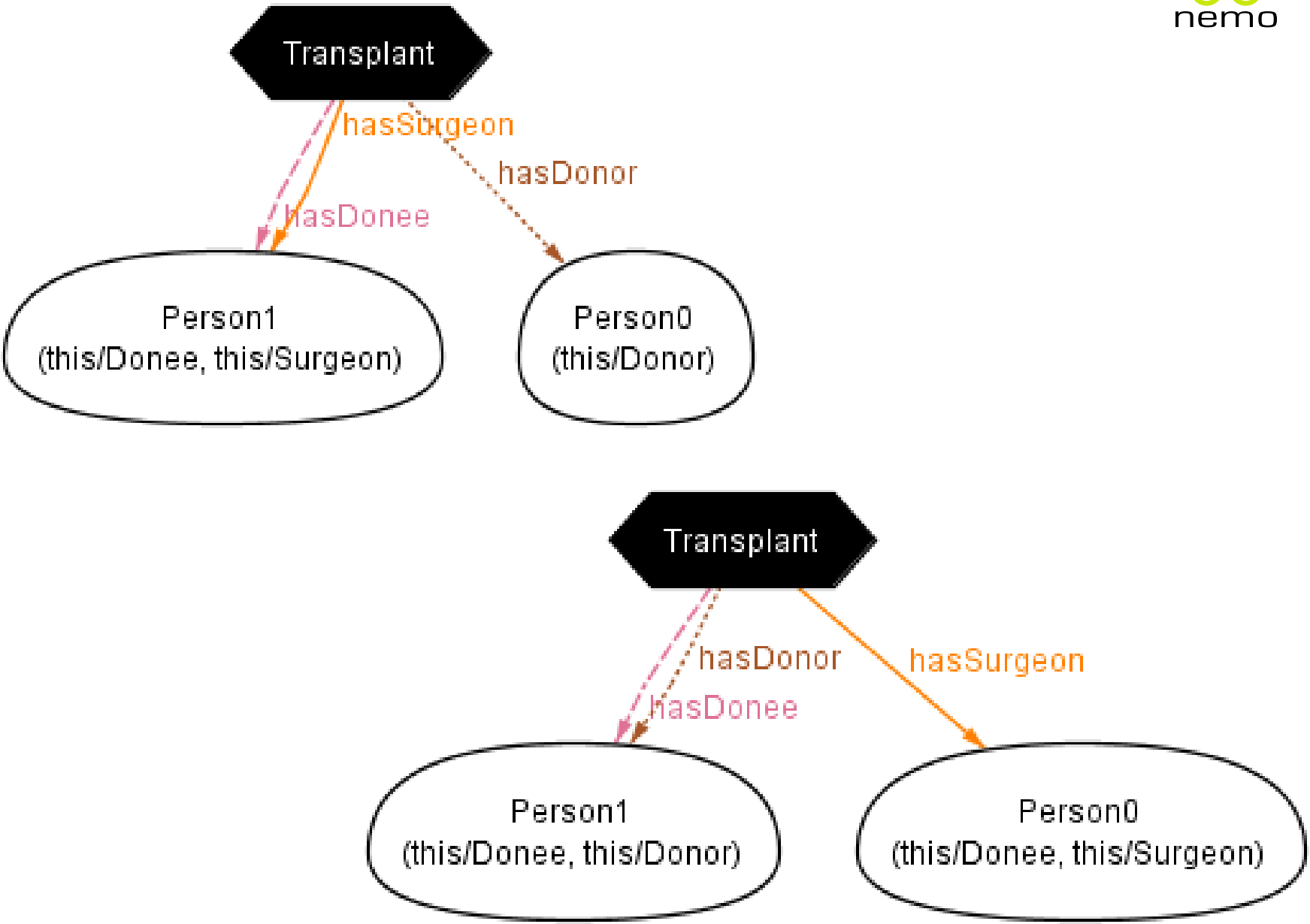
$\Box(\forall x\ \text{Student}(x) \rightarrow \exists y\ \text{Educational Institution}(y) \wedge \text{Enrolled-at}(x,y))$

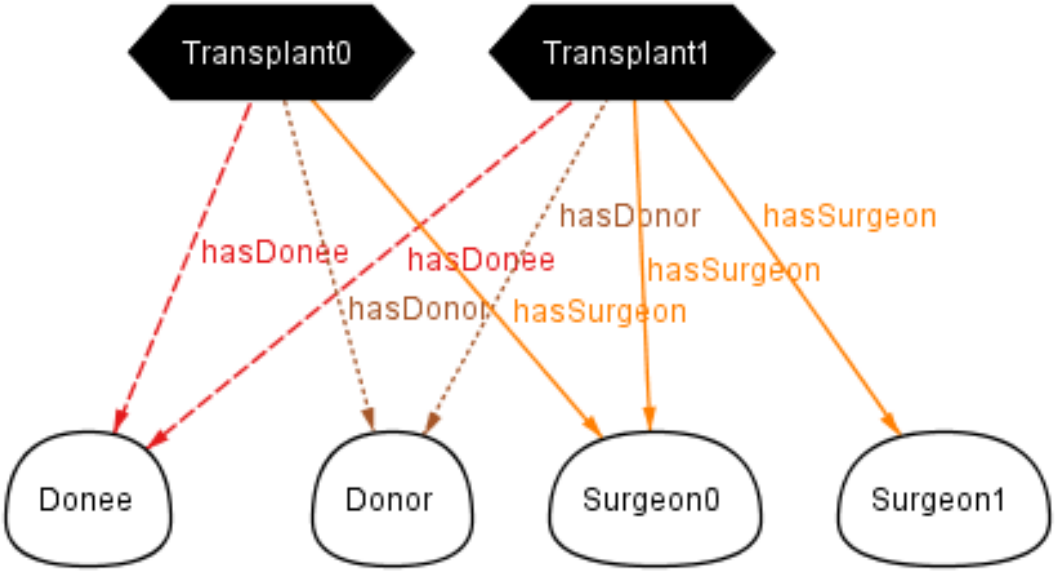
…

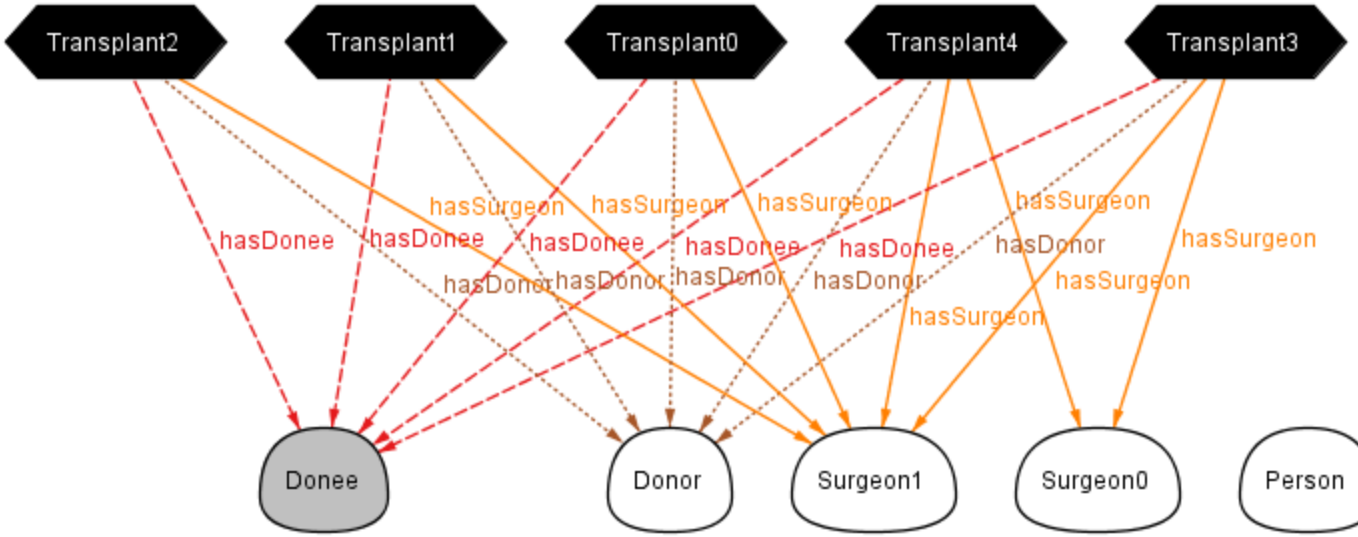

1..*
«mediation»
«role»
Transplant Surgeon
«kind»
Person
«role»Organ Donee
1
«mediation»
1..*
«mediation»
«role»Organ Donor
«relator»Transplant
1
1..*
1..*


Transplant
hasDonee
hasDonor
hasSurgeon
hasSurgeon
hasSurgeon
Donee
Donor
Surgeon1
Surgeon0
Surgeon2

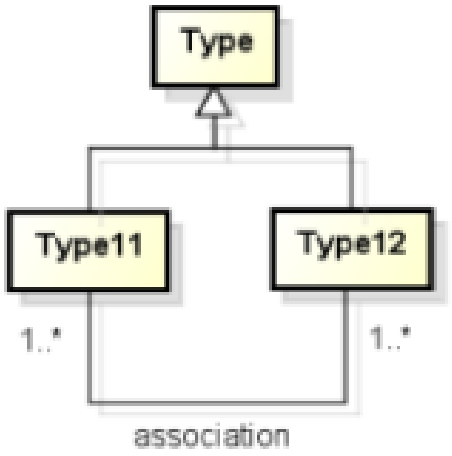

Transplant
hasSurgeon
hasDonor
hasDonee
Person
(this/Donee, this/Donor, this/Surgeon)


Transplant
hasSurgeon
hasDonor
hasDonee
Person1
(this/Donee, this/Surgeon)
Person0
(this/Donor)
Transplant
hasDonor
hasSurgeon
hasDonee
Person1
(this/Donee, this/Donor)
Person0
(this/Donee, this/Surgeon)

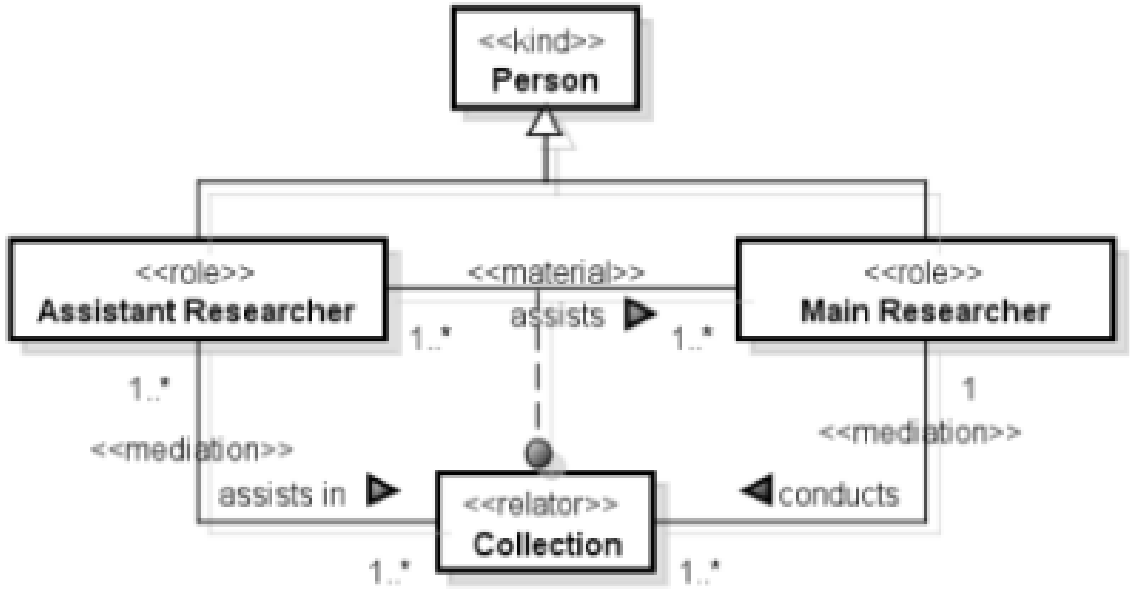

Transplant0
Transplant1
hasDonee
hasDonee
hasDonor
hasSurgeon
hasDonor
hasSurgeon
hasSurgeon
Donee
Donor
Surgeon0
Surgeon1


Transplant2
Transplant1
Transplant0
Transplant4
Transplant3
hasDonee
hasDonee
hasDonee
hasDonee
hasDonee
hasSurgeon
hasSurgeon
hasSurgeon
hasSurgeon
hasSurgeon
hasSurgeon
hasSurgeon
hasSurgeon
hasDonor
hasDonor
hasDonor
hasDonor
hasDonor
Donee
Donor
Surgeon1
Surgeon0
Person

Relation between Overlapping Sybtypes (ROS)

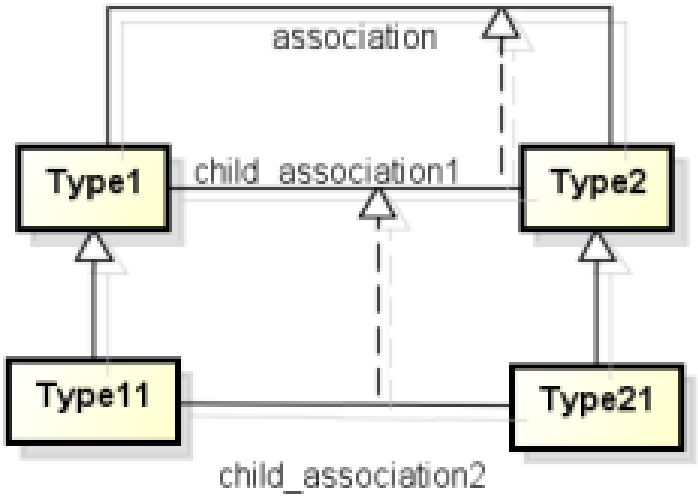


(a)

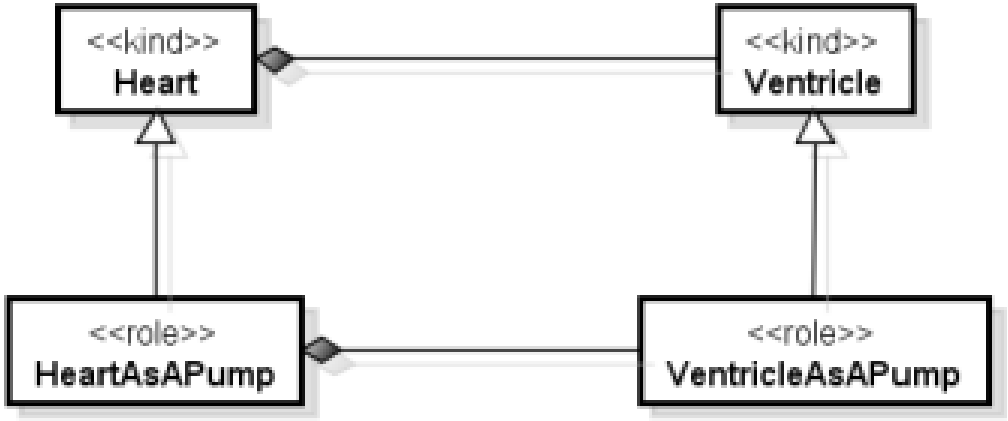


(b)

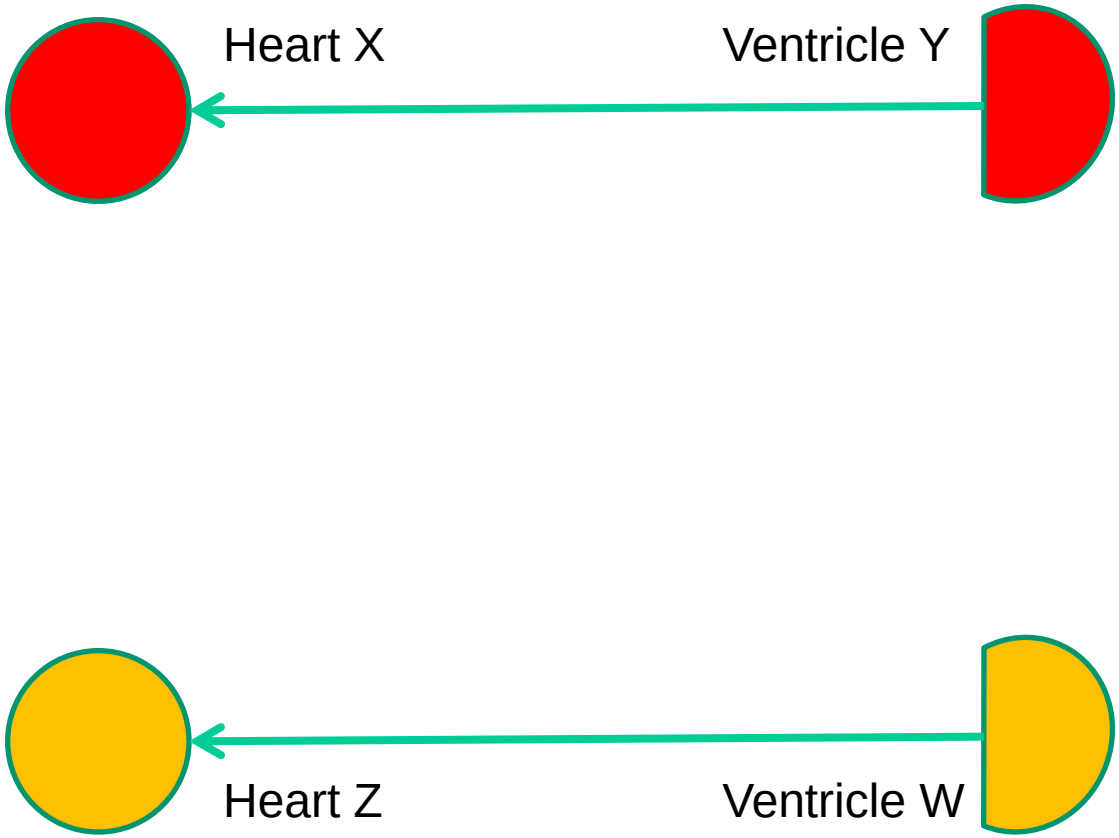
Relation Specialization (RS)

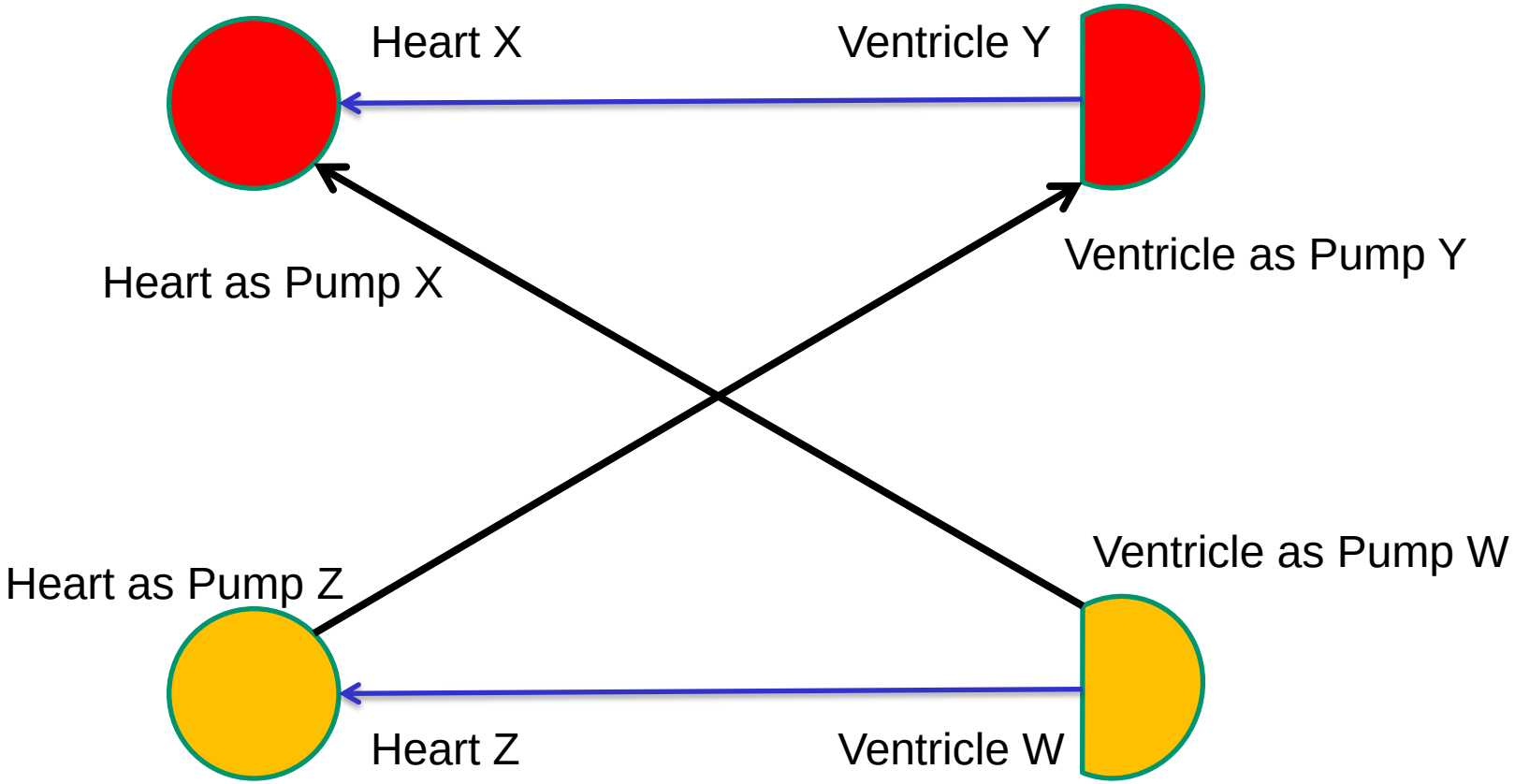


(a)



(b)


Heart X
Ventricle Y
Heart Z
Ventricle W


Heart X
Ventricle Y
Heart as Pump X
Ventricle as Pump Y
Heart as Pump Z
Ventricle as Pump W
Heart Z
Ventricle W

Sample of Ontologies Analyzed

1. A Conceptual Model that describes a Brazilian Health Organization
2. A Conceptual Model that describes the Organizational Structure of Brazilian Federal Universities
3. A Conceptual Model that describes a Domain of Online Mentoring Activities
4. An Ontology representing the domain of Transport Optical Network Architectures
5. An Ontology in the Biodiversity Domain
6. A Heart Electrophysiology Reference Ontology
7. An Ontology in the Domain of Normative Acts
8. An Ontology of Public Tenders
9. An Ontology in the Domain of Brazilian Federal Organizational Structures

Ontology	#GC	#RBOS	#RS	#IA	#TRR	#PAR
1	1	1	0	1	0	0
2	1	1	1	3	0	0
3	3	2	0	1	0	0
4	9	1	3	3	4	1
5	2	2	11	3	3	0
6	2	0	2	2	0	2
7	8	3	0	3	0	0
8	2	4	1	0	0	0
9	2	0	2	1	2	1
Total	**30**	**14**	**20**	**17**	**9**	**4**
Percentage	**100%**	**77.78%**	**66.67%**	**88.89%**	**33.33%**	**33.33%**

Few modelers, however, have had the experience of subjecting their models to continual, automatic review. Building a model incrementally with an analyzer, simulating and checking as you go along, is a very different experience from using pencil and paper alone. The first reaction tends to be amazement: modeling is much more fun when you get instant, visual feedback. When you simulate a partial model, you see examples immediately that suggest new constraints to be added. Then the sense of humiliation sets in, as you discover that there's almost nothing you can do right.

Daniel Jackson

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GUIZZARDI, G., Theoretical Foundations and Engineering Tools for Building Ontologies as Reference Conceptual Models, Semantic Web Journal, Editors-in-Chief: Pascal Hitzler and Krzysztof Janowicz, IOS Press, Amsterdam, 2010.

BRAGA, B., ALMEIDA, J.P.A., GUIZZARDI, G.; BENEVIDES, A.B. Transforming OntoUML into Alloy: Towards Conceptual Model Validation using a Lightweight Formal Method, Innovations in System and Software Engineering (ISSE), Springer-Verlag, 2010.

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GUIZZARDI, G.; GRAÇAS, A.P., GUIZZARDI, R.S.S., Design Patterns and Inductive Modeling Rules to Support the Construction of Ontologically Well-Founded Conceptual Models in OntoUML, 3rd International Workshop on Ontology-Driven Information Systems (ODISE 2011), London, UK (together with the 23rd International Conference on Advanced Information System Engineering - CAiSE'11).

http://nemo.inf.ufes.br/

gguizzardi@inf.ufes.br