Ontology of Physics for Biology (OPB): Annotation of biological data and models

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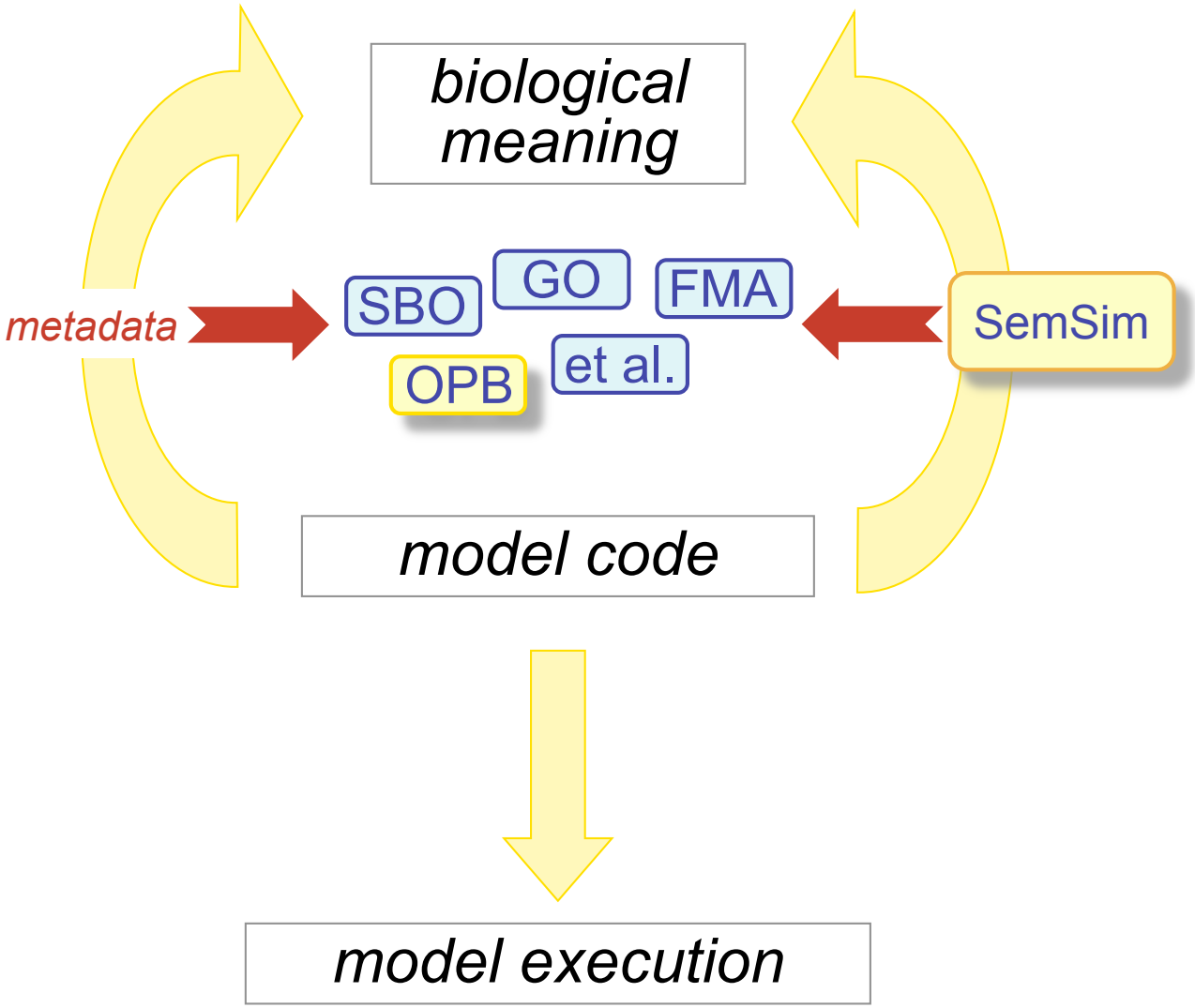
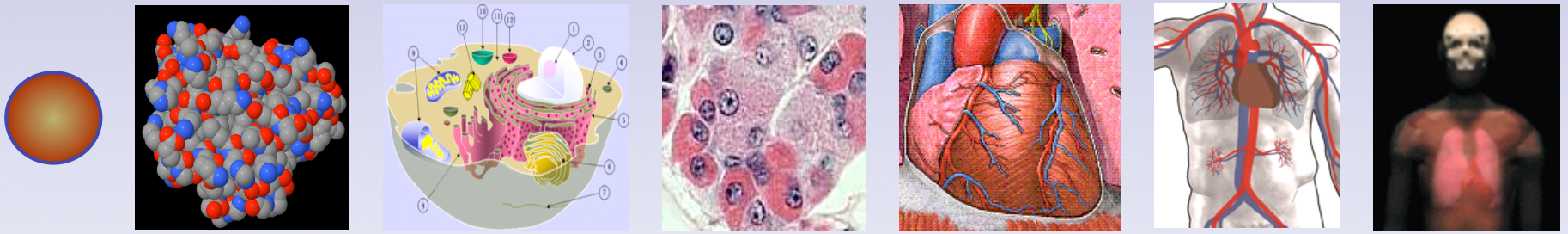
University of Washington, Seattle

CellML Workshop 2009, Waiheke Island, NZ

Overview:


biological meaning
metadata
SBO
GO
FMA
OPB
et al.
SemSim
model code
model execution

Ontologies for multidomain physics



> 100 elements	>> 100,000 molecule types	>400 cell-part types	>600 cell types	63 organ types	12 organ systems	2 bodies

Foundational Model of Anatomy

Gene Ontology

Cell Type

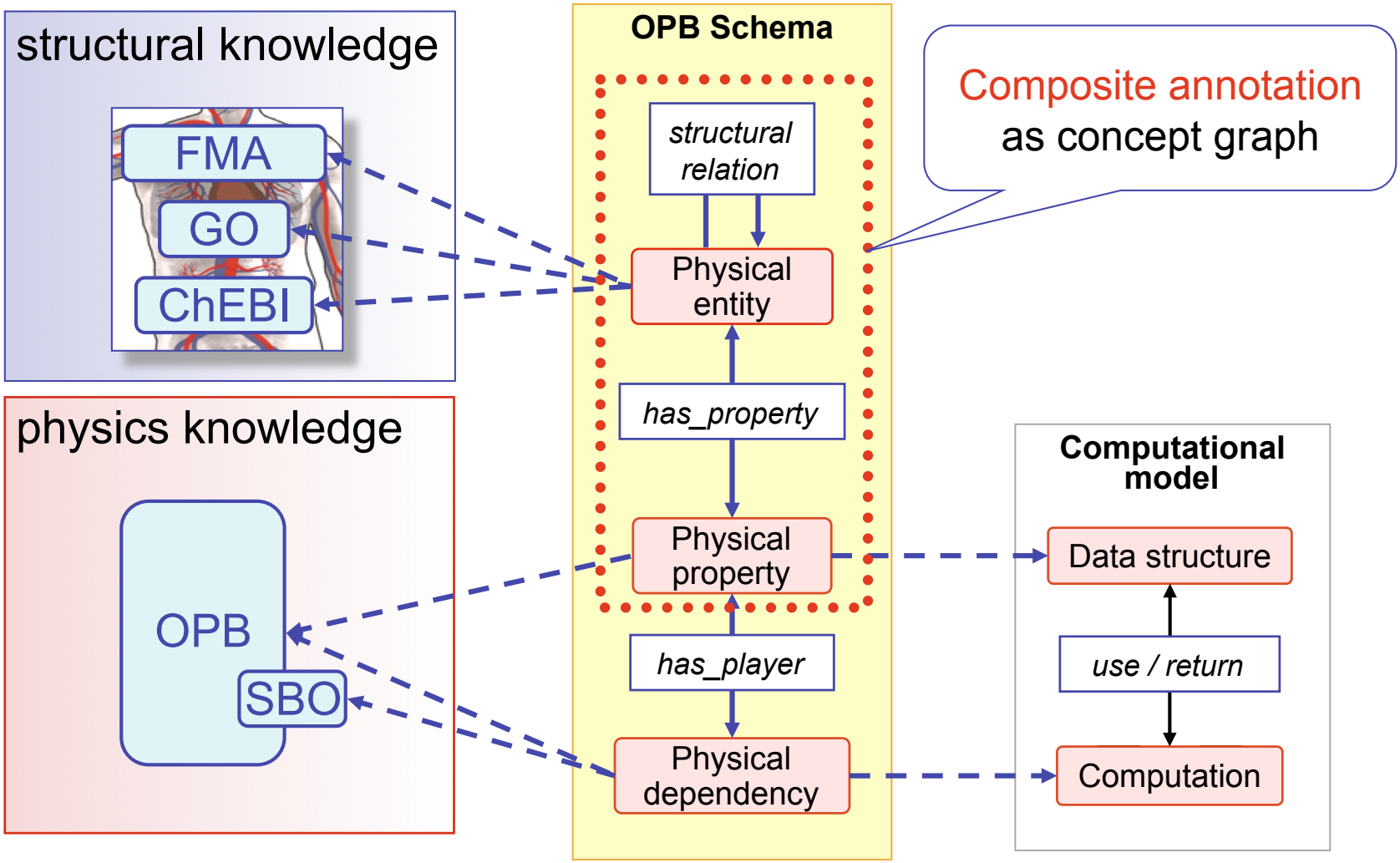
ChEBI

OPB

SBO

Domain	Process
fluids	blood flow, respiratory gas flow…
solids	myocardial contraction, leg motion…
chemical kinetics	metabolism, gene expression, cell signaling…
electrochemistry	transmembrane potential, action potential…
diffusion	intracellular calcium dynamics…
heat transfer	body temperature regulation…

OPB/SemSim schema: “composite annotation”



OPB foundational theory — system dynamics

Engineering system dynamics

- Bond graph theory
  Karnopp, Margolis, Rosenberg (1968)
- EngMath - Ontology for Engineering Mathematics
  Gruber, Olsen (1994)
- PHYSYS - Physical Systems Ontology
  Borst, Top, Akkermans (1994)

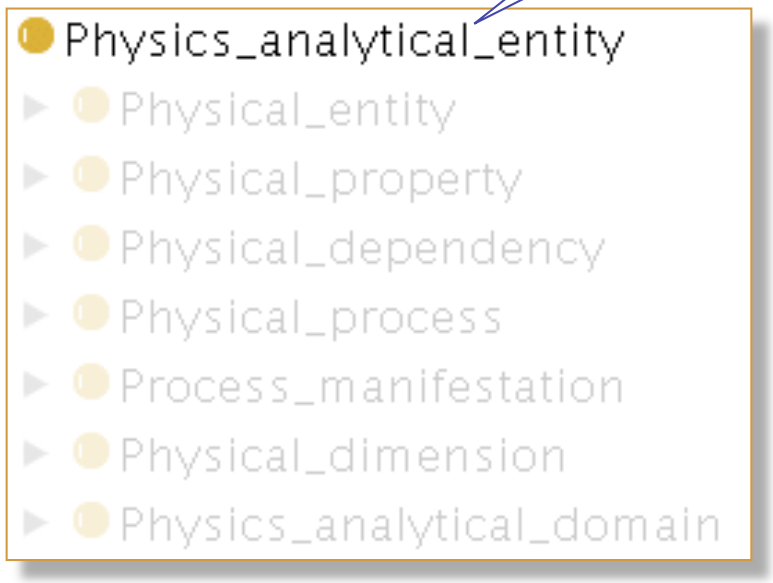
Biochemical system dynamics

- Network thermodynamics
  Oster, Perelson, Katchalsky (1971)
  Mickulecky (1983)
  Beard, Qian (2008)

OPB:*Physics analytical entity*

A *Physics analytical entity* is an abstraction of the real world created within the science of classical physics for the description of physical entities and the analysis of physical processes.

OPB



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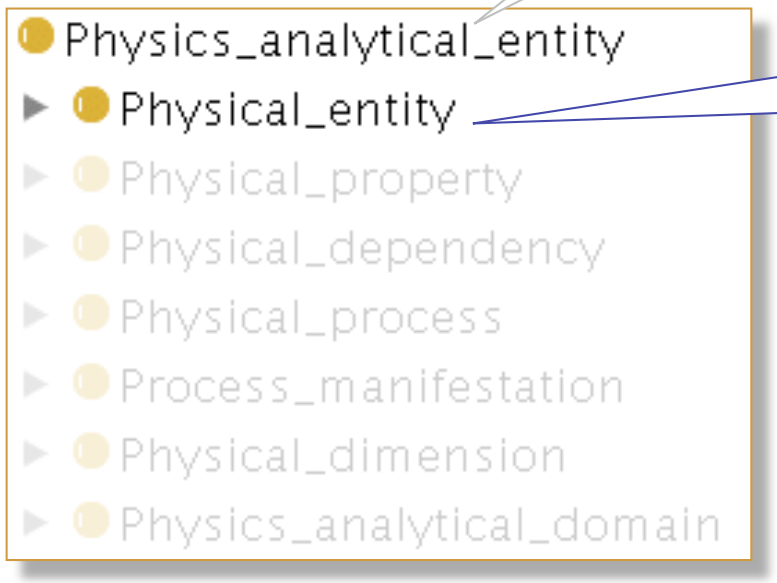

A *Physical entity* is a spatial, temporal, or energetic abstraction of the physical world.

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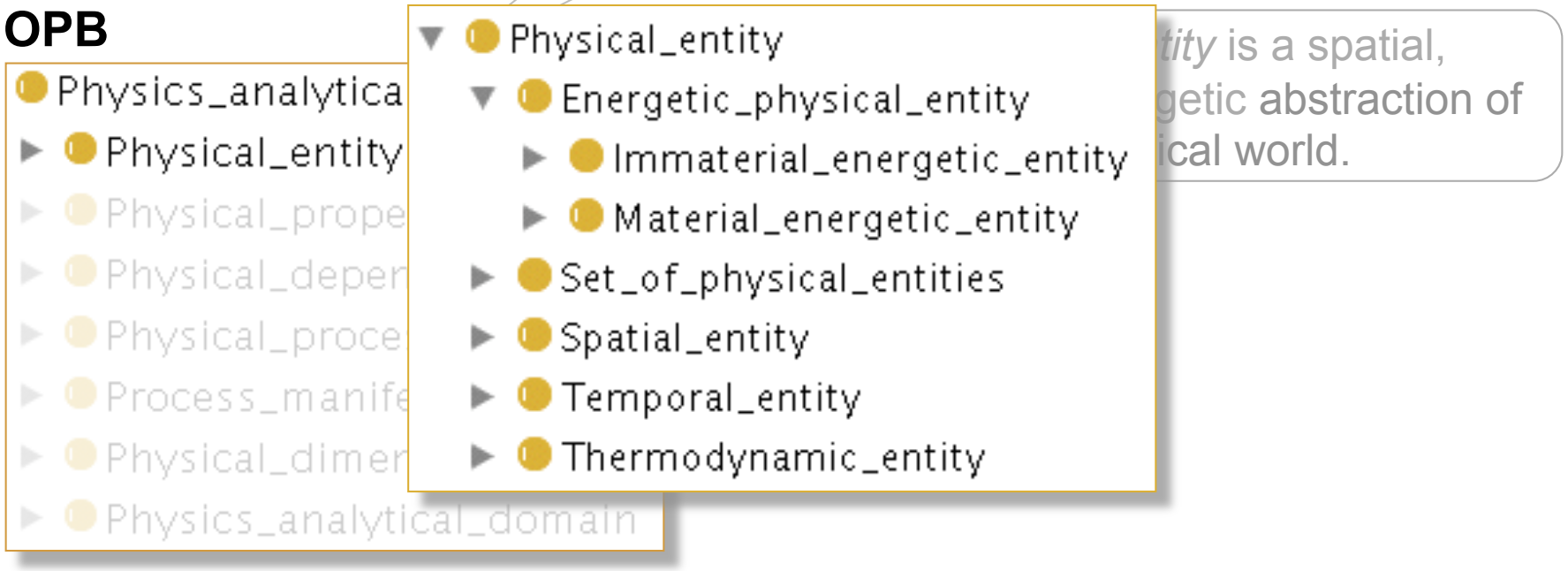


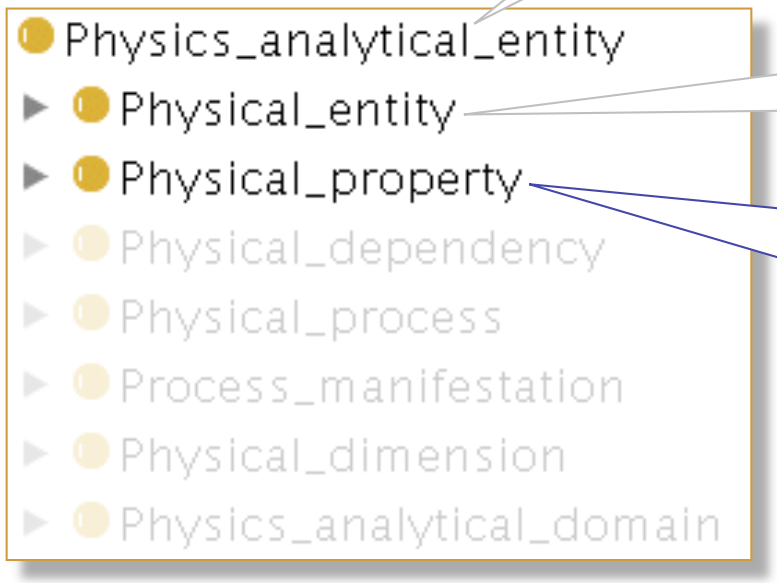
OPB:*Physical property*

A *Physics analytical entity* is an abstraction of the real world created within the science of classical physics for the description of physical entities and the analysis of physical processes.

A *Physical entity* is a spatial, temporal, or energetic abstraction of the physical world.

A *Physical property* is a quantifiable attribute of a *Physical entity* whose value can be determined by physical measurement at a moment in time.

OPB



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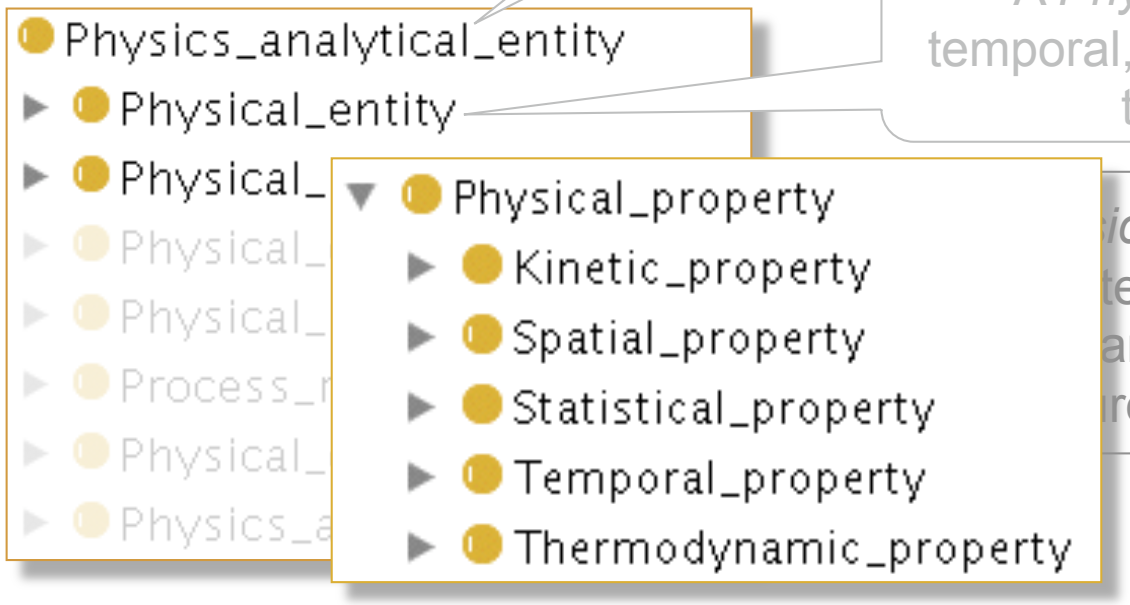
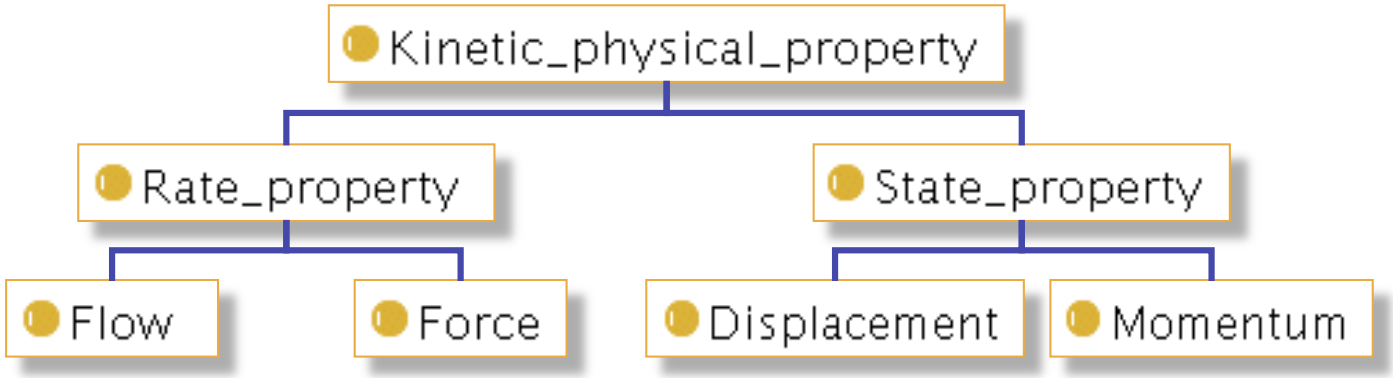
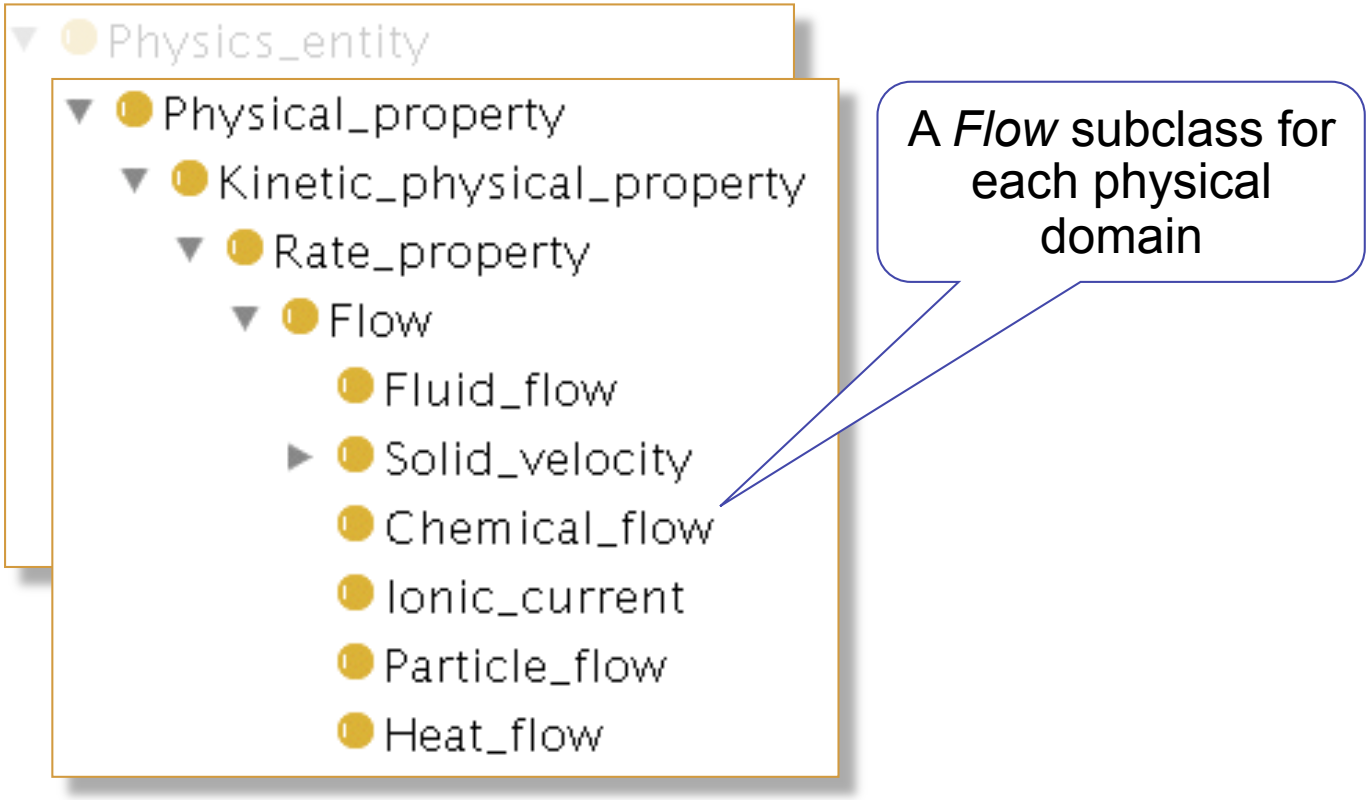


Kinetic physical property class taxonomy



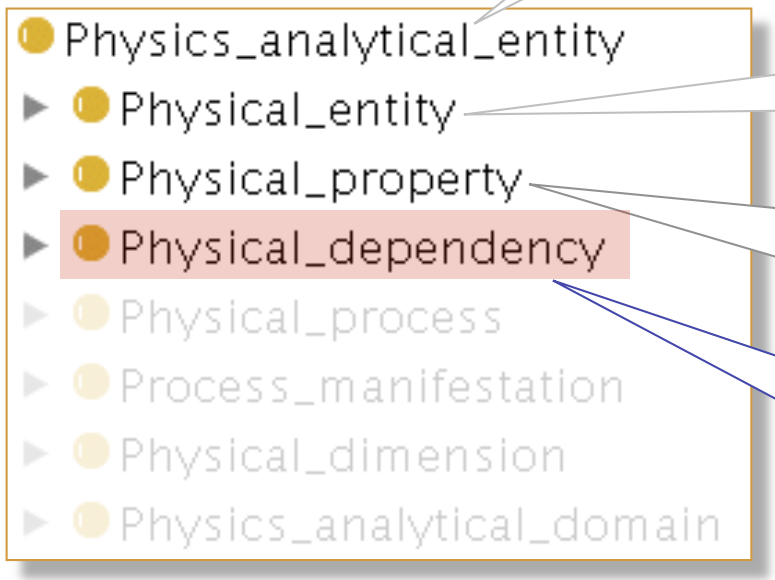
Physical domain				
fluids	volume flow	pressure	volume	pressure momentum
solids	velocity	force	displacement	solid momentum
chemical kinetics	molar flow	chemical potential	chemical amount	----
electrophysiology	ionic current	voltage	charge	----
diffusion	particle flow	chemical potential	particle number	----
heat transfer	heat flow	temperature	heat amount	----

Kinetic physical property by domain



OPB:*Physical dependency*

OPB



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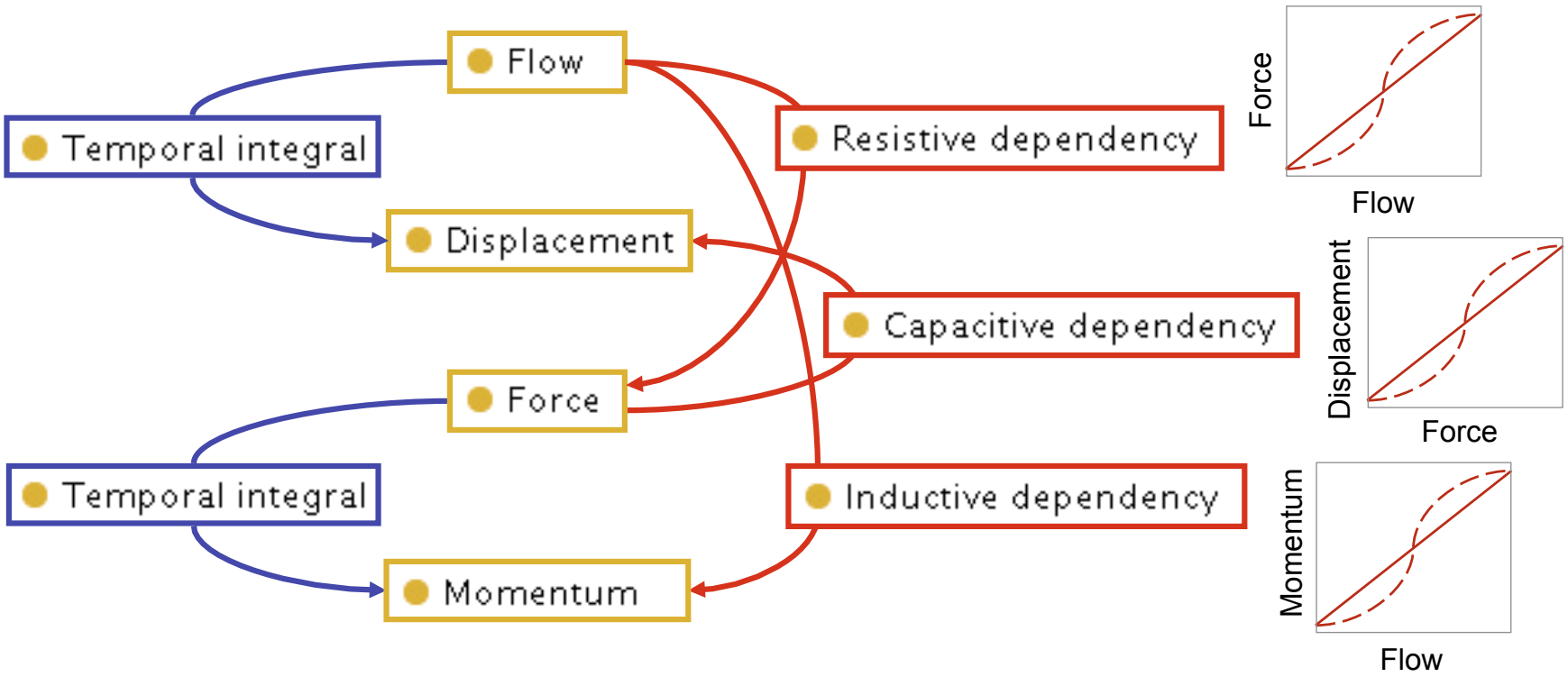
A *Physical property* is a quantifiable attribute of a *Physical entity* whose value can be determined by physical measurement at a moment in time.

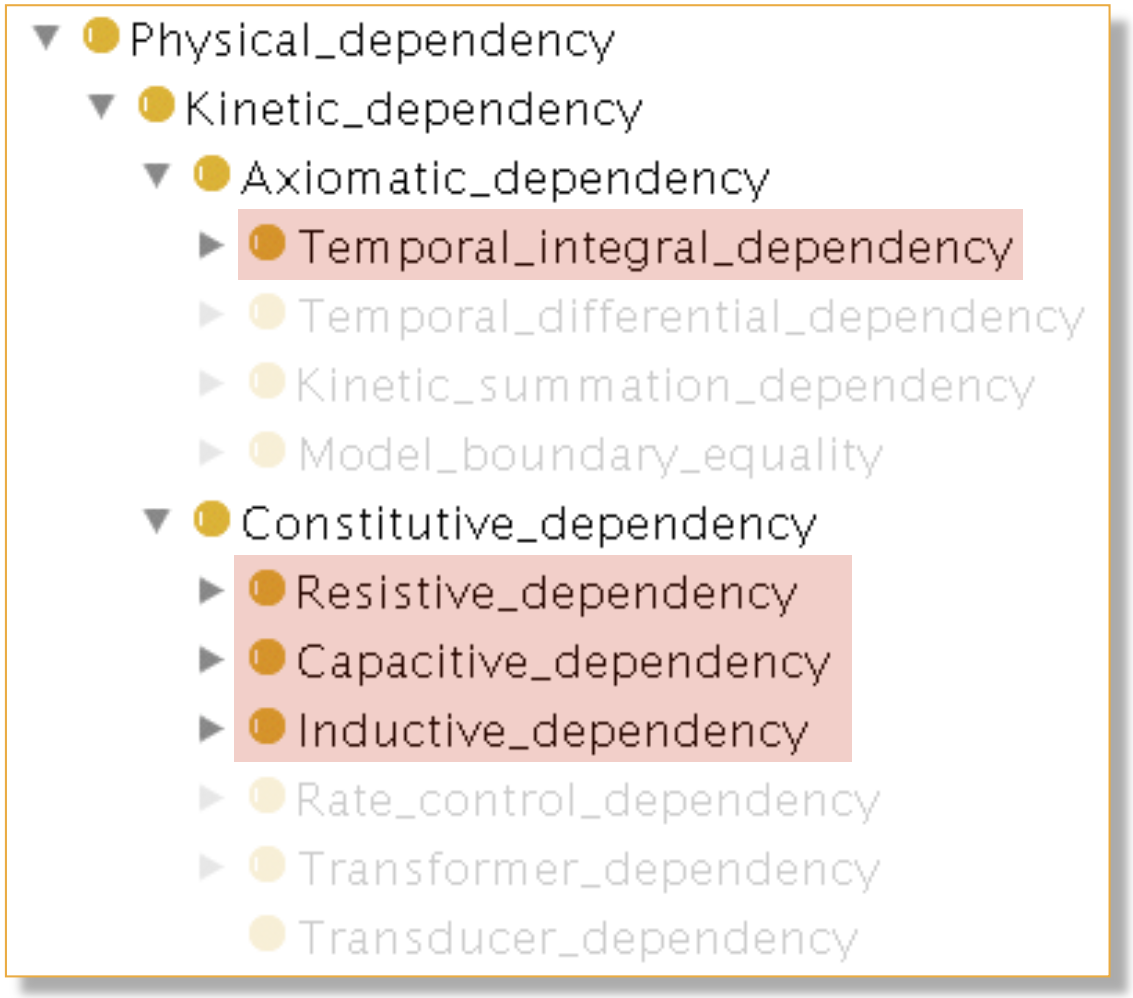
A *Physical dependency* is a dependency between the magnitudes of *Physical properties* according to an axiom or empirical law of physics.

OPB:*Constitutive dependency*



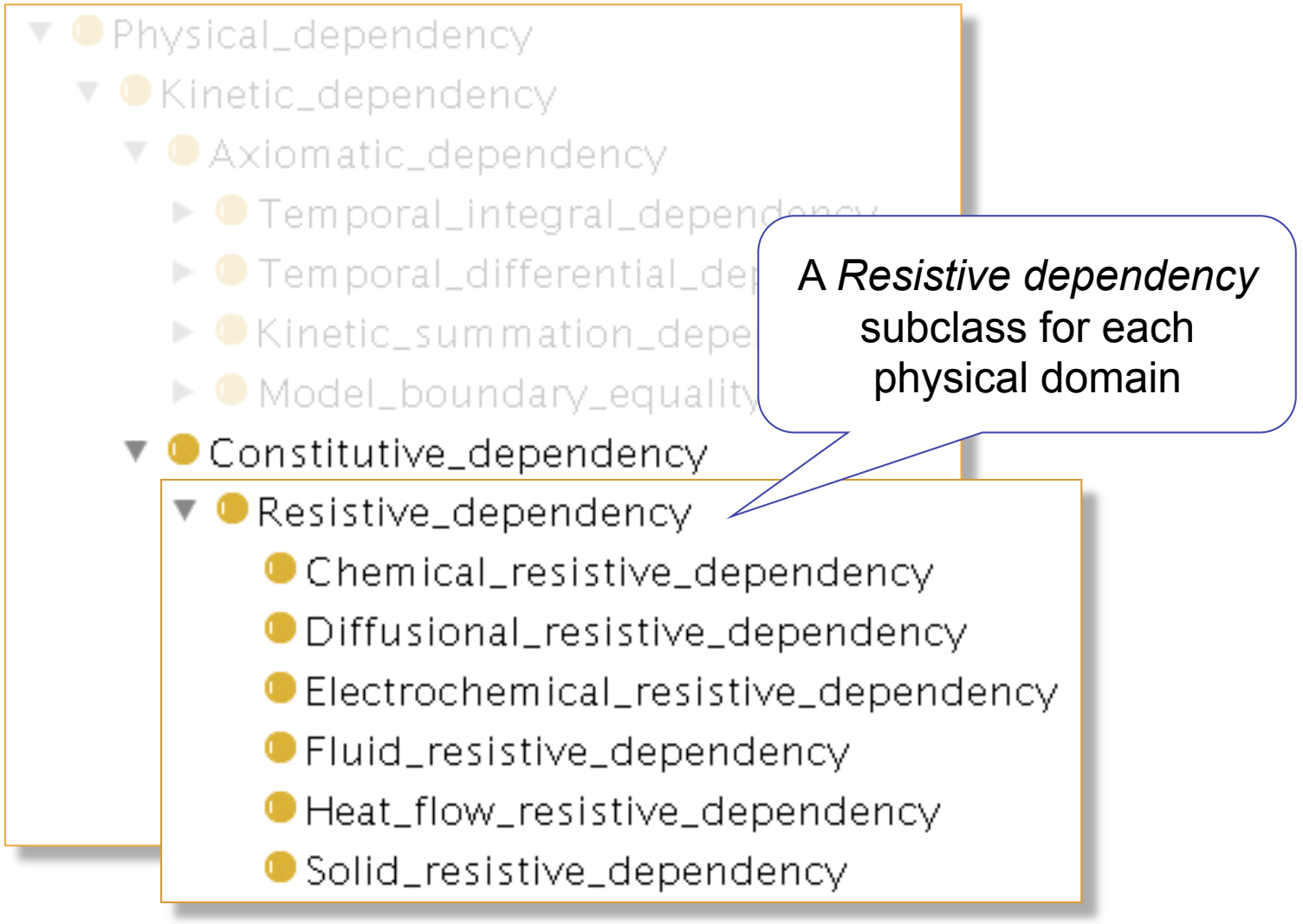
Physical dependency class hierarchy

OPB



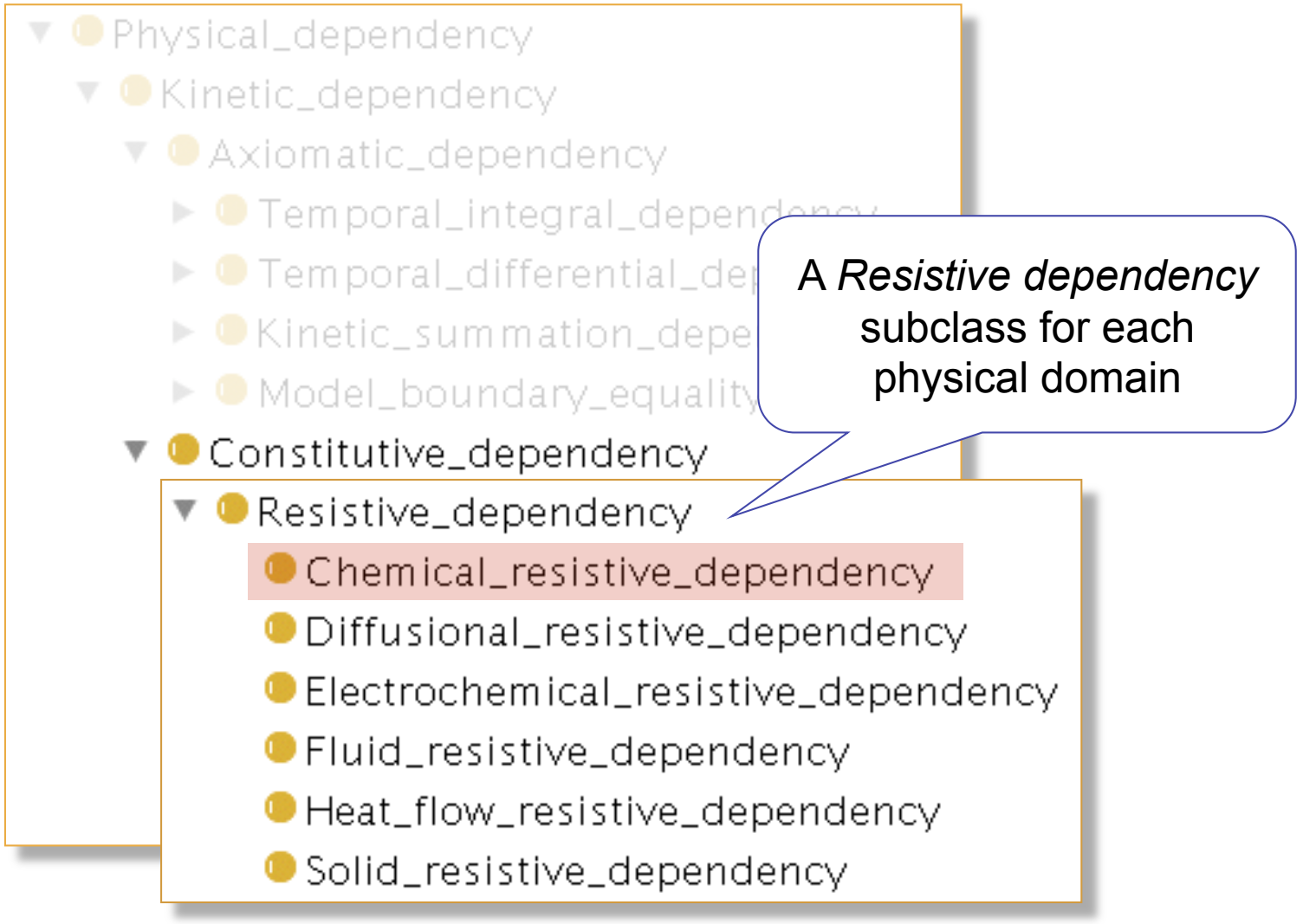
Physical dependency by domain

OPB

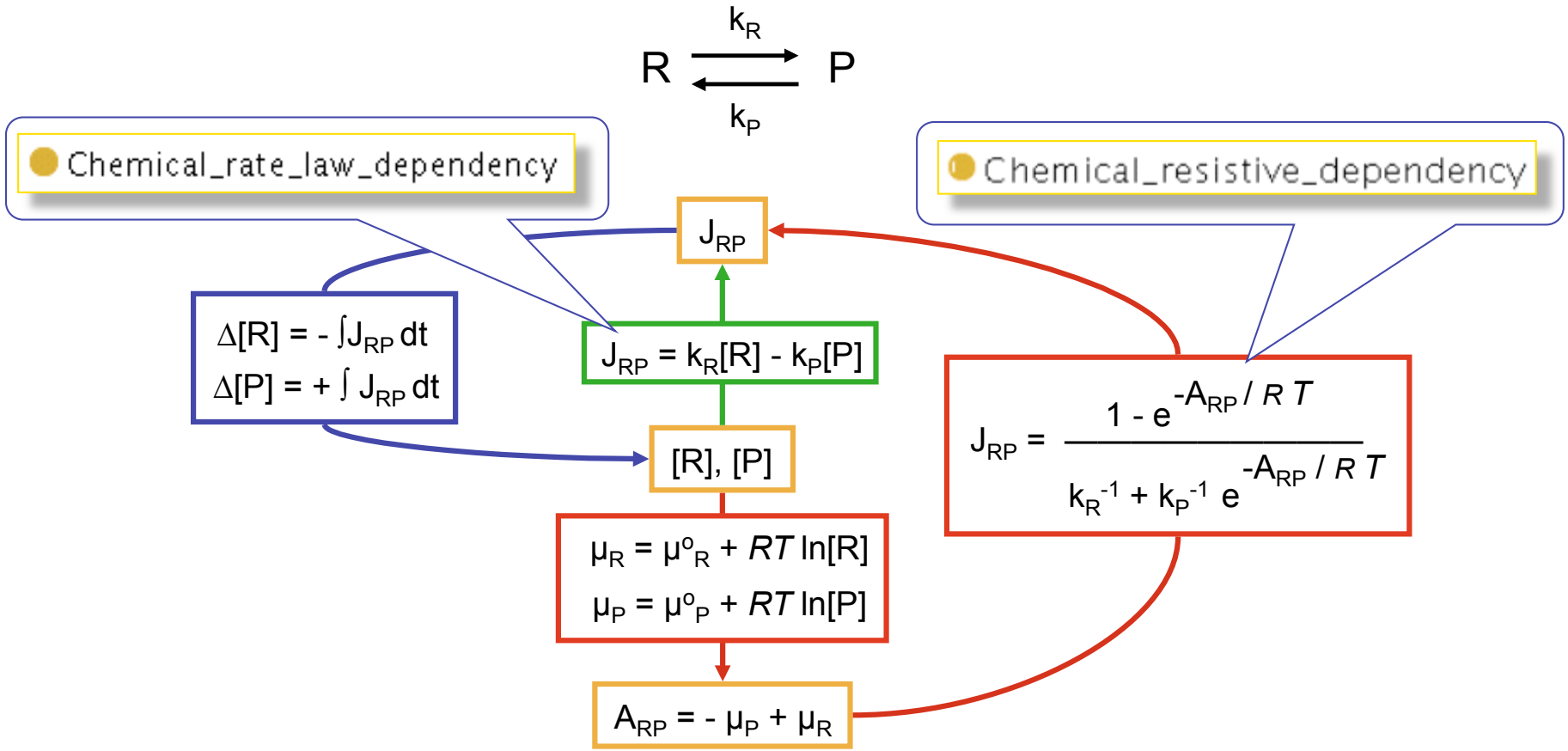


Physical dependency by domain

OPB



OPB: *Chemical kinetic domain* dependencies



see: Beard & Qian (2008)

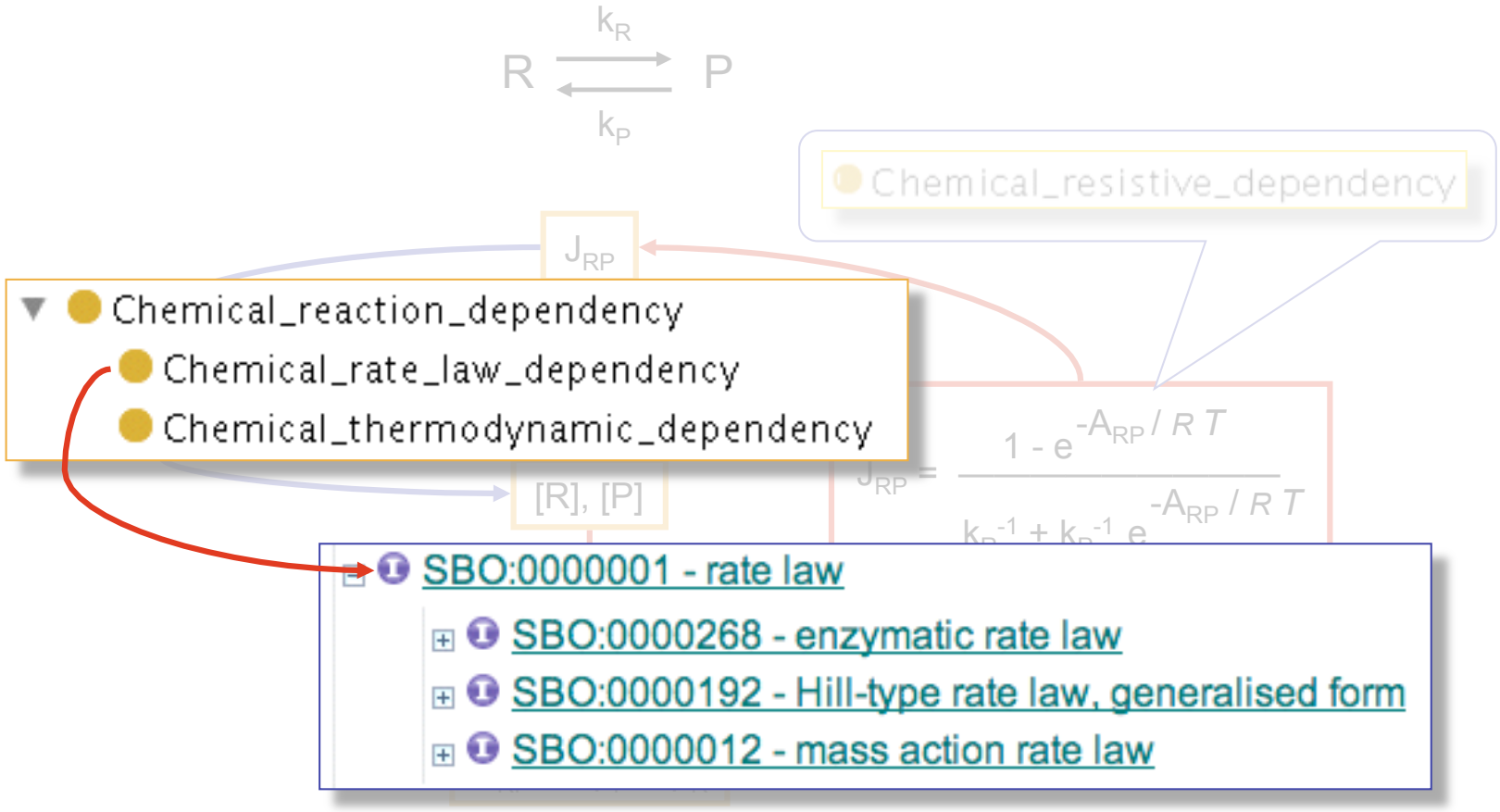
R = molar gas constant

T = temperature

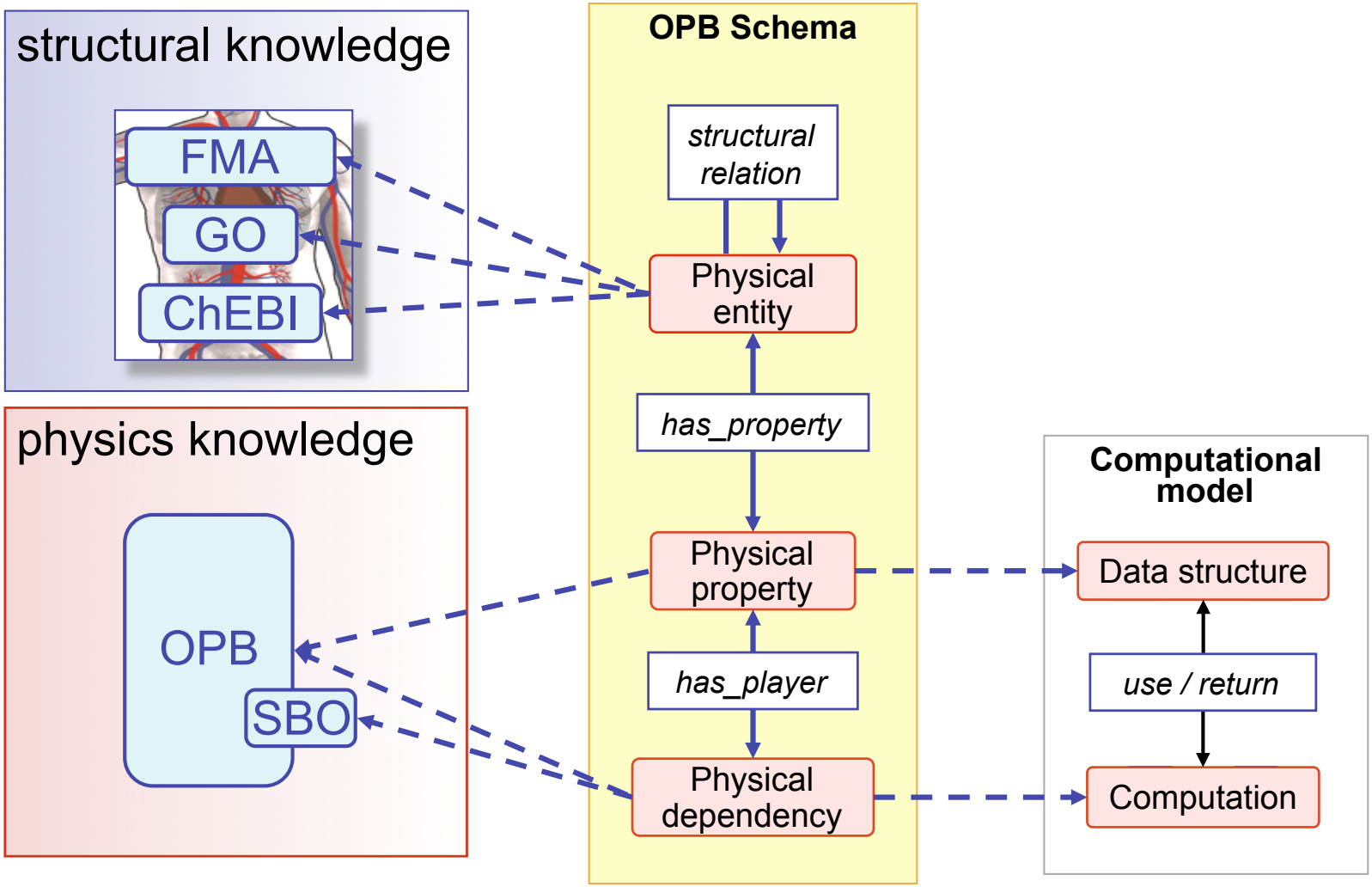
μ_P = chemical potential

A_{RP} = affinity

OPB-to-SBO mappings?



OPB/SemSim schema: models to ontologies



Acknowledgements

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- Michal Galdzicki (Grad student)
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- Daniel L. Cook, MD, PhD (Res Prof)

UW contributors:

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- Todd Detwiler

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- Erik Butterworth
- Hong Qian
- Adriana Emmi
- Fred Bookstein

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