

MIE

2008



How Granularity Issues Concern Biomedical Ontology Integration

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Introduction

Problem 1

Problem 2

Problem 3

Conclusion

Introduction

- Background: emerging biomedical ontologies: standard descriptions of types of bio(medical) entities
- Challenge: interlink ontologies and enable interoperability
- Goal: share data both within and across disciplinary boundaries
- Proposal: BioTop, an integrative **domain top level ontology** for life science

E Beisswanger, U Hahn, H Stenzhorn, S Schulz: BioTop: A Life Science Upper Domain Ontology. Forthcoming in Applied Ontology 2008

Biomedical Ontologies...

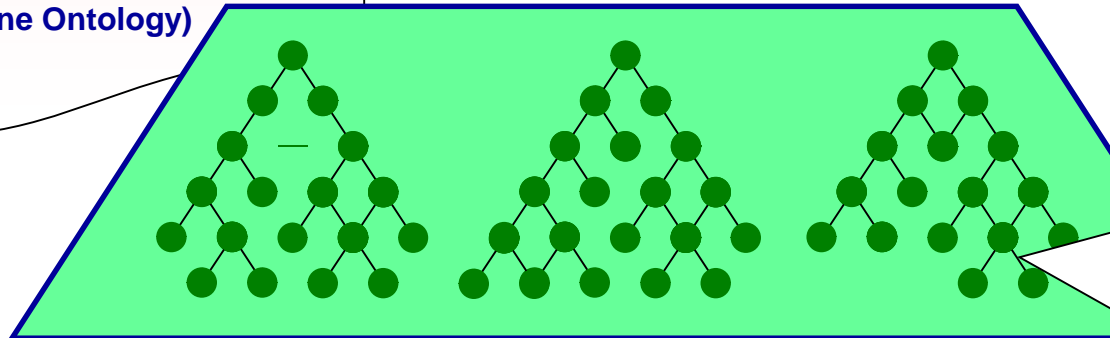
**Domain
Ontologies**

...are artifacts whose
representational units are
intended to designate classes of
biomedical entities, their properties,
and their interrelations

Biomedical Ontologies...

- **Transcription**
 - DNA-dependent transcription
 - antisense RNA transcription
 - mRNA transcription
 - rRNA transcription
 - tRNA transcription
 - ...
- (from Gene Ontology)

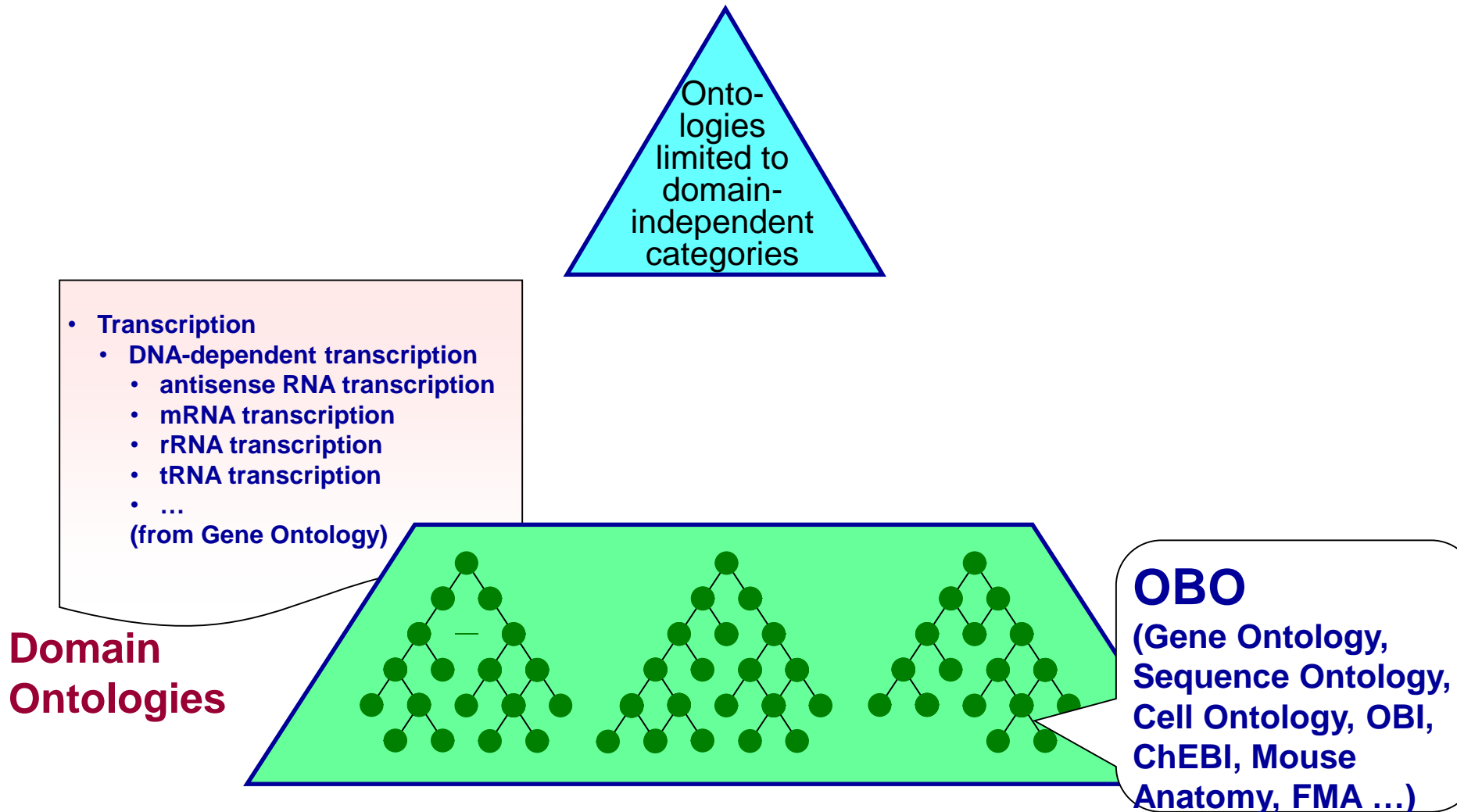
**Domain
Ontologies**



OBO

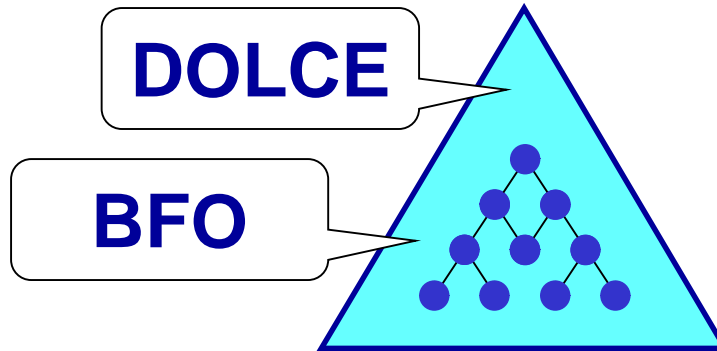
(Gene Ontology,
Sequence Ontology,
Cell Ontology, OBI,
ChEBI, Mouse
Anatomy, FMA ...)

Upper Ontologies...



Upper Ontologies

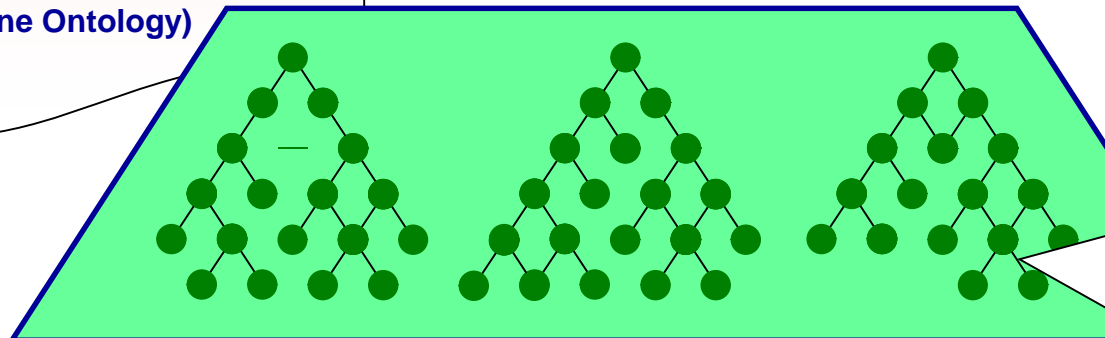
Upper Ontology



- Entity
- Continuant
 - Dependent Continuant
 - Realizable Entity
- Function
- Role
- Independent Continuant
- Object
- Object Aggregate
- Occurrent

- Transcription
 - DNA-dependent transcription
 - antisense RNA transcription
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 - ...
 (from Gene Ontology)

Domain Ontologies



OBO
 (Gene Ontology,
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Middle-level ?

Upper Ontology

DOLCE

BFO

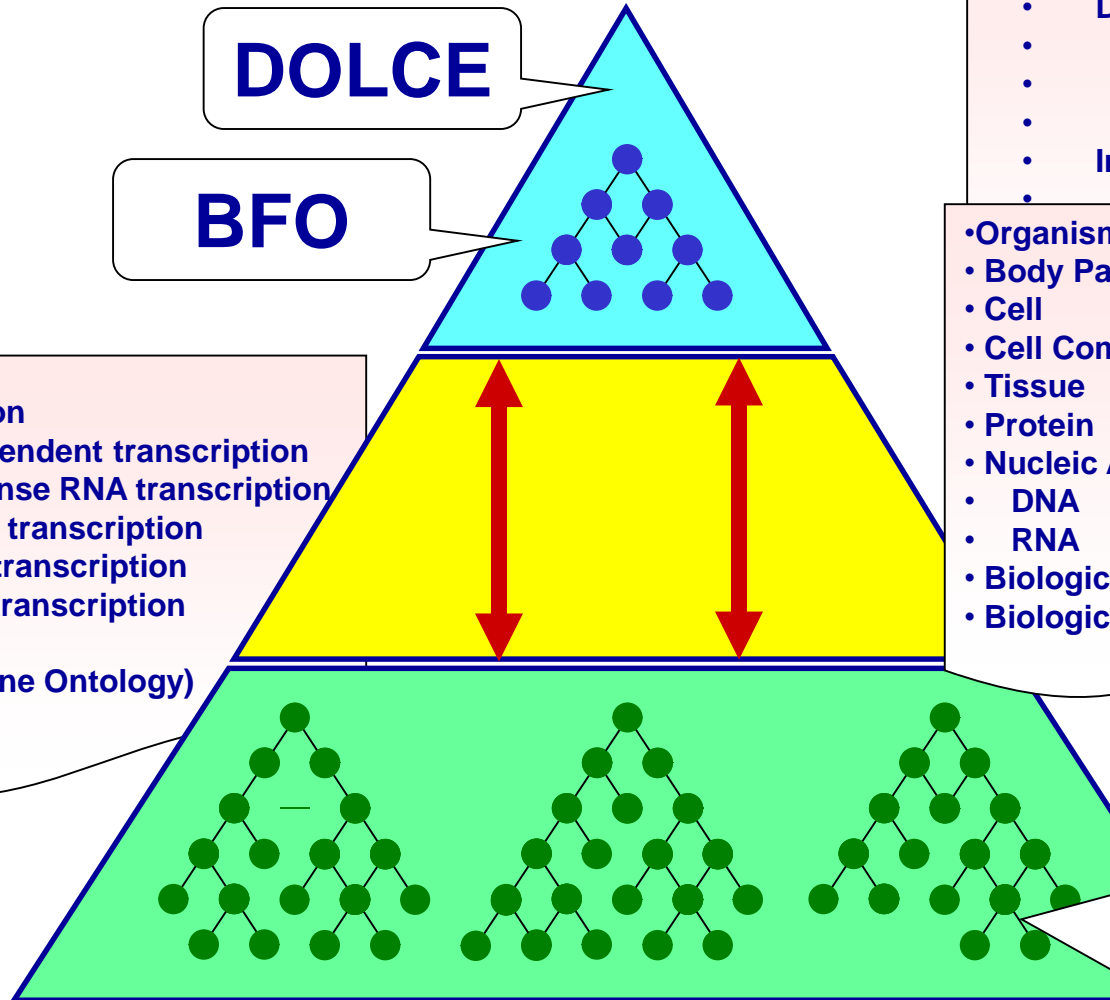
- Entity
- Continuant
 - Dependent Continuant
 - Realizable Entity
- Function
- Role
- Independent Continuant
- Object

- Organism
- Body Part
- Cell
- Cell Component
- Tissue
- Protein
- Nucleic Acid
 - DNA
 - RNA
- Biological Function
- Biological Process

- Transcription
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 - ...
 (from Gene Ontology)

Domain Ontologies

OBO
(Gene Ontology, Sequence Ontology, Cell Ontology, OBI, ChEBI, Mouse Anatomy, FMA ...)



Top Domain Ontologies

Upper Ontology

DOLCE

BFO

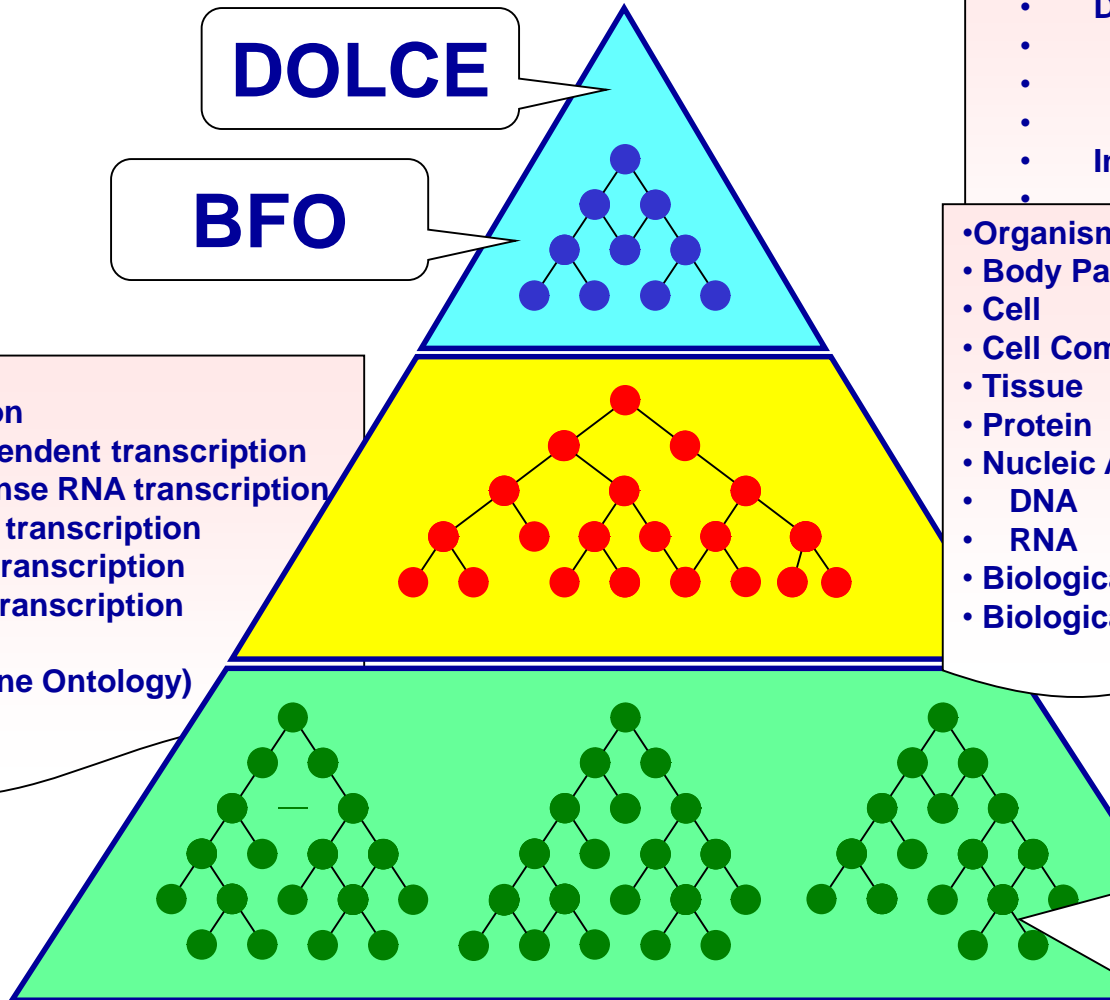
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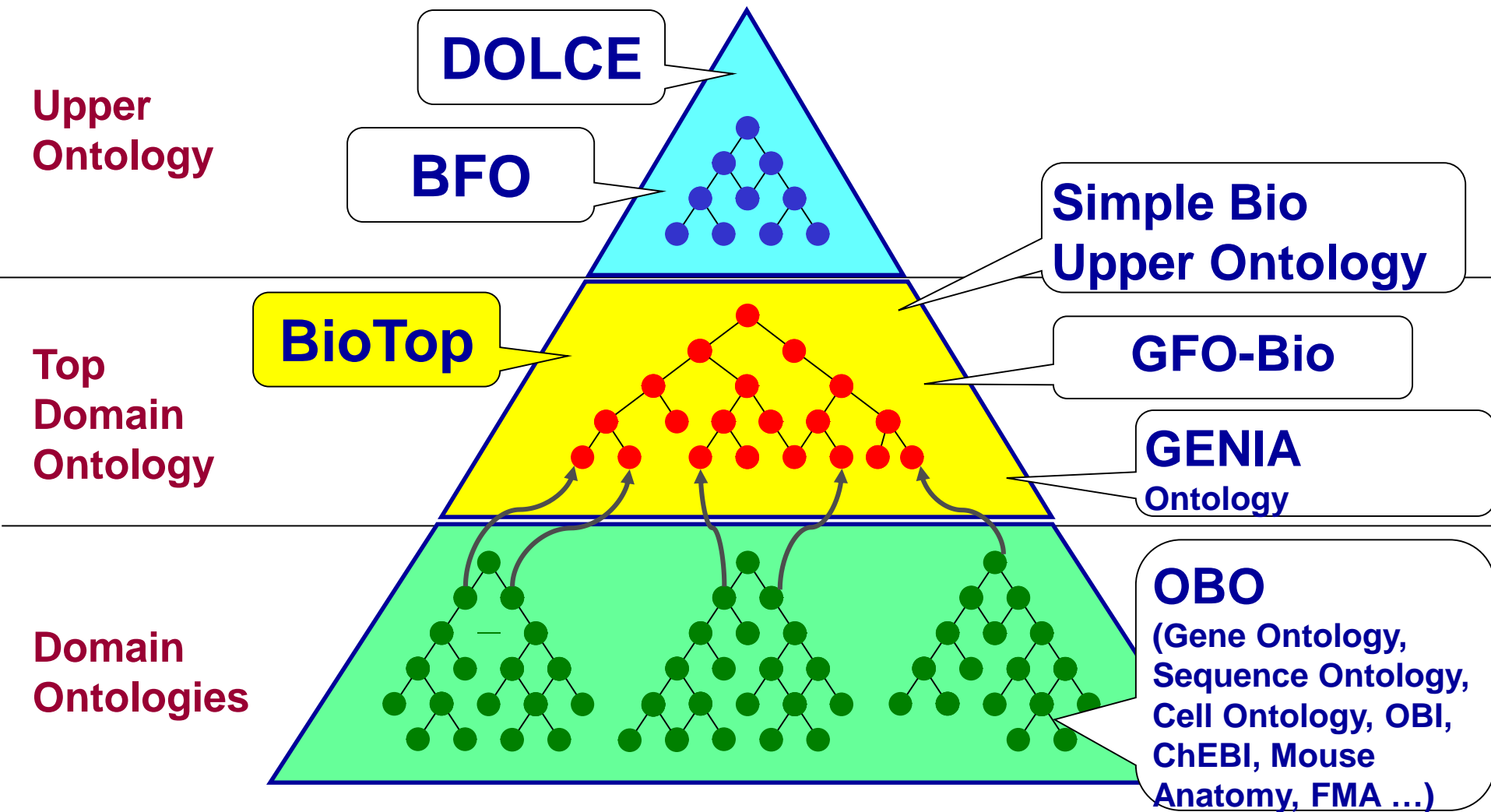
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Domain Ontologies

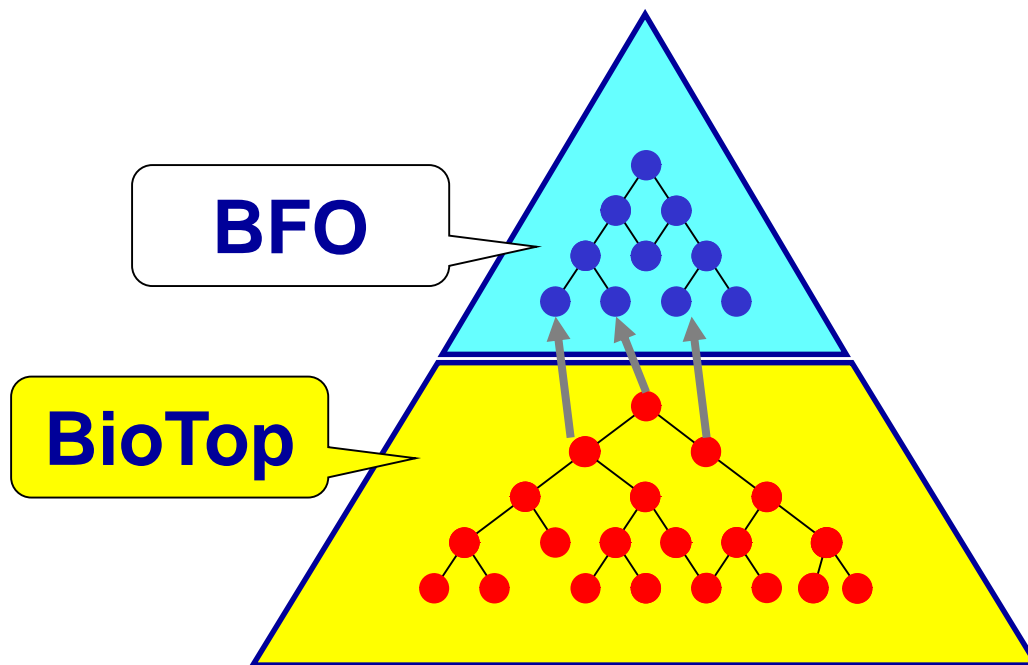
OBO
(Gene Ontology, Sequence Ontology, Cell Ontology, OBI, ChEBI, Mouse Anatomy, FMA ...)



Lower-level alignment



Upper-level alignment



Introduction

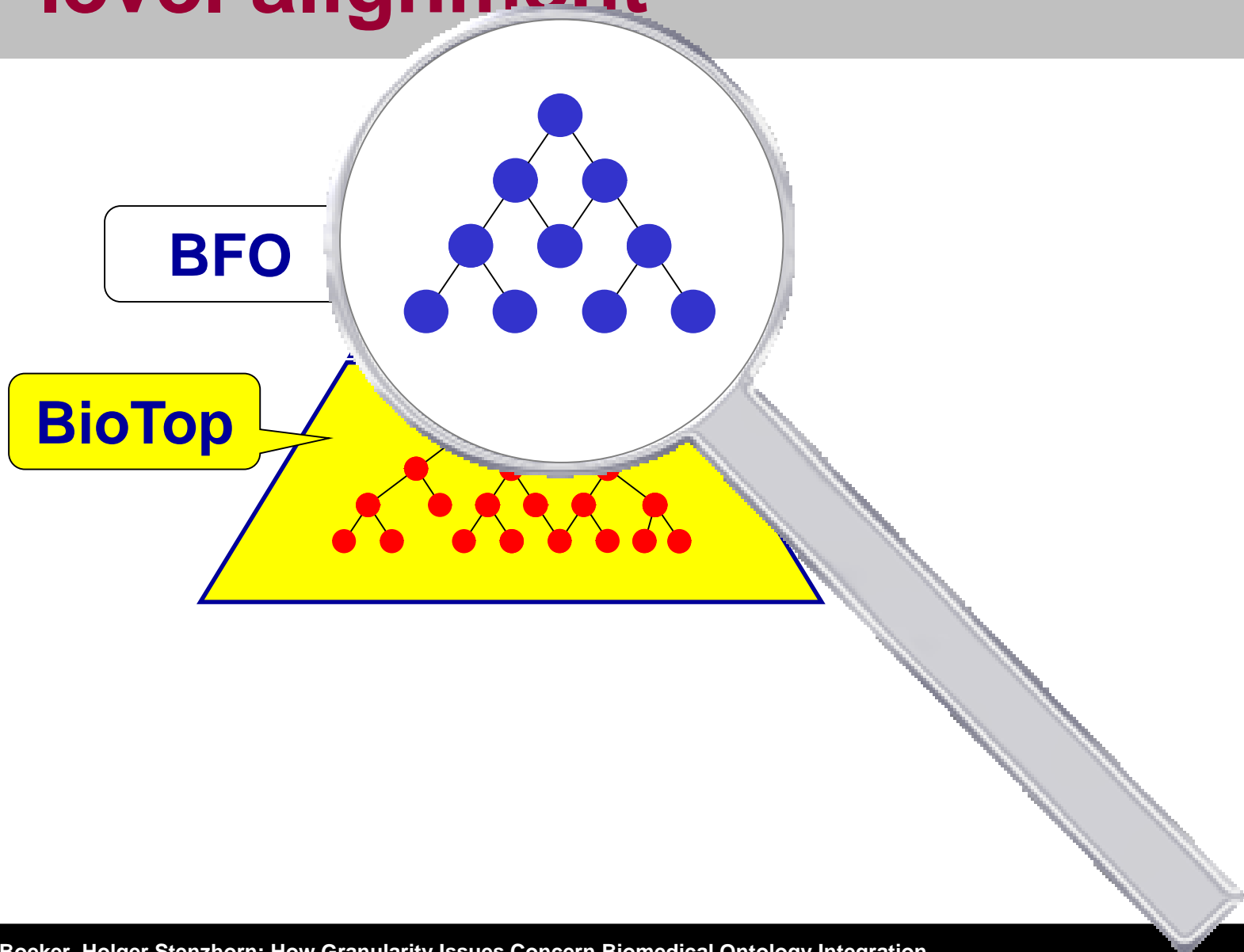
Problem 1

Problem 2

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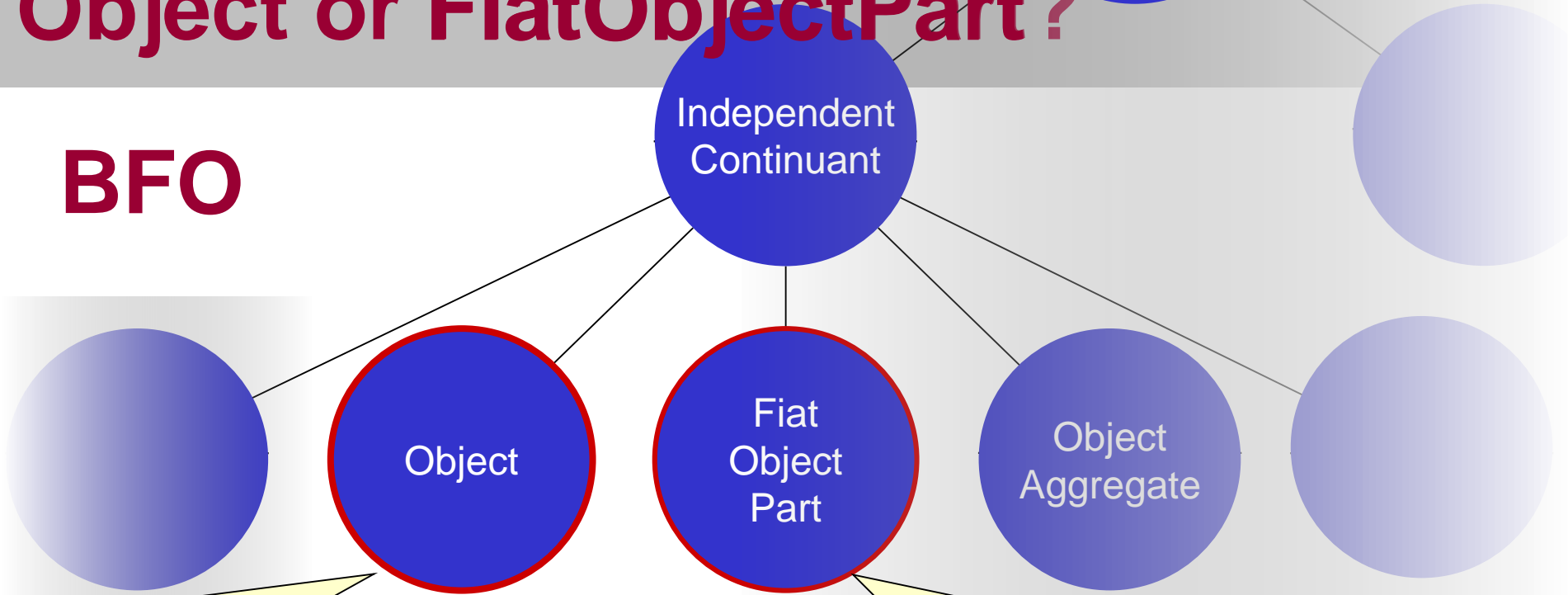
Conclusion

Upper-level alignment



Object or FiatObjectPart?

BFO



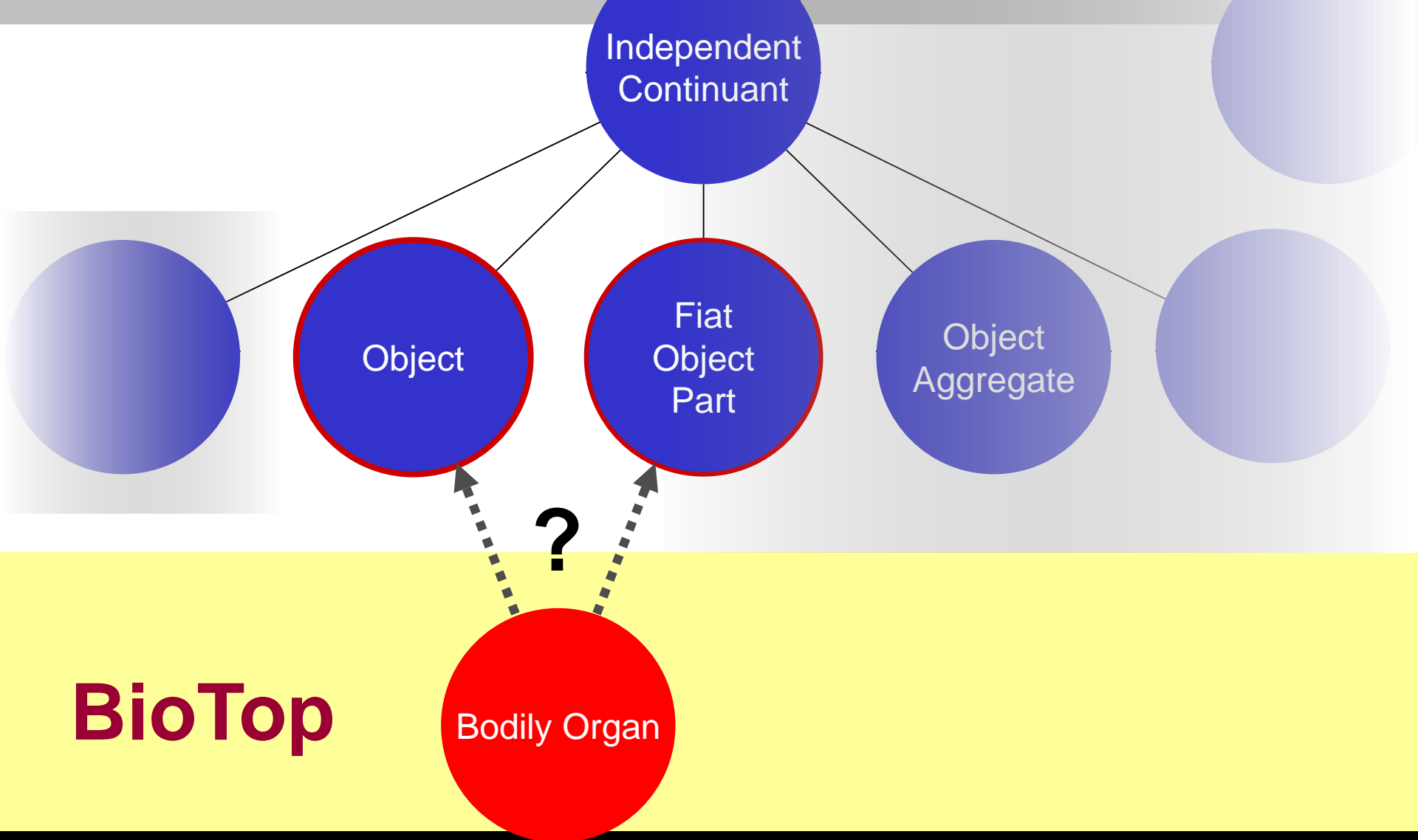
An independent continuant entity that is spatially extended, maximally self-connected and self-contained (the parts are not separated from each other by spatial gaps), and possesses an internal unity; the identity of substantial objects is independent of that of other entities and can be maintained through time and through loss and gain of parts and qualities.

Examples: *an organism, a chair, a cell, a lung, an apple.*

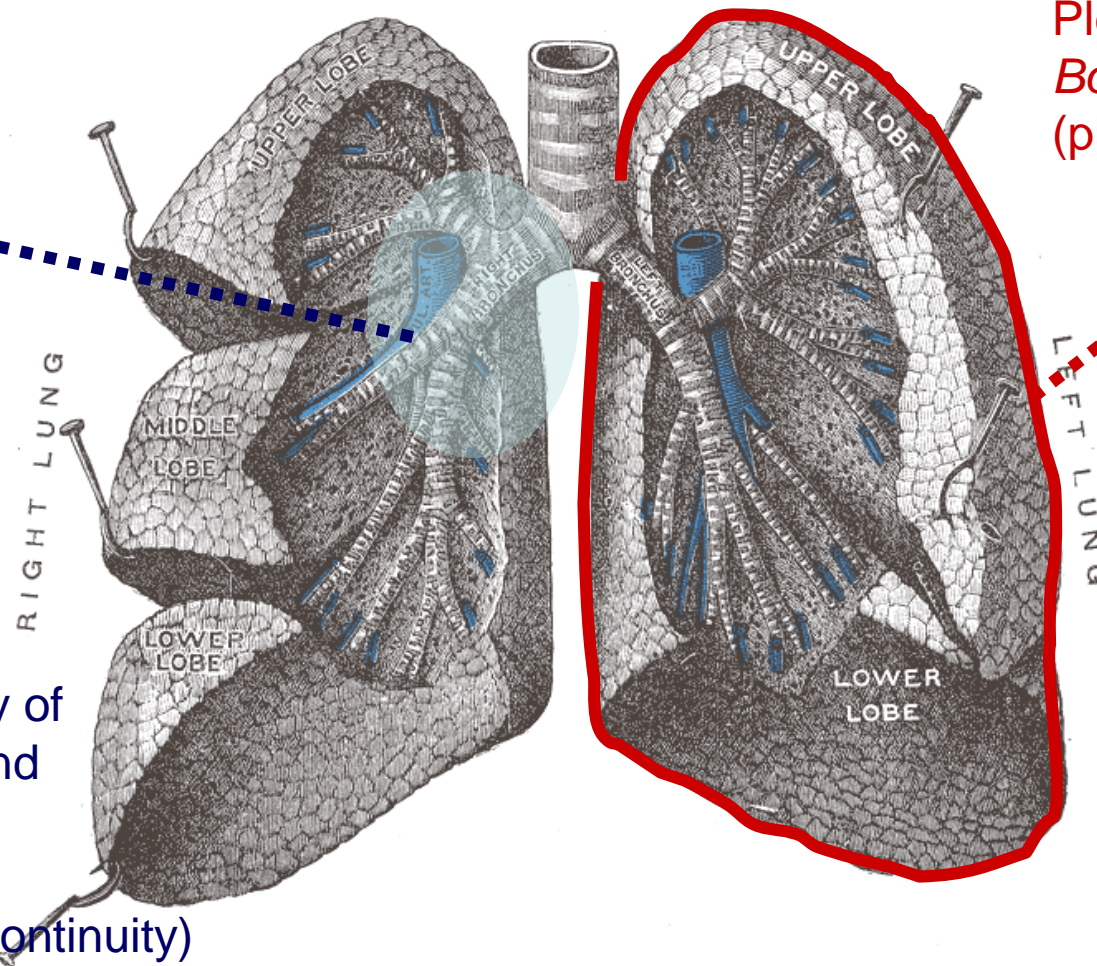
An independent continuant entity that is part of a object but is not demarcated by any physical discontinuities.

Examples: *upper and lower lobes of the left lung, the dorsal and ventral surfaces of the body, the east side of Copenhagen, the lower right portion of a human torso.*

Object or FiatObjectPart?



Object or FiatObjectPart?



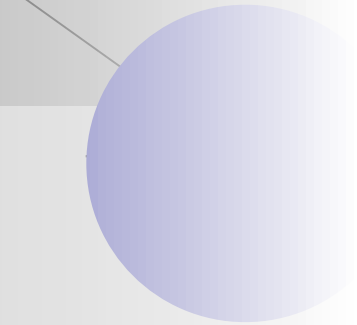
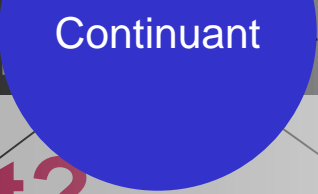
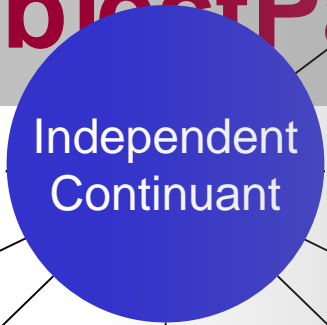
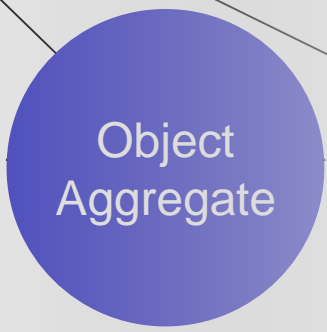
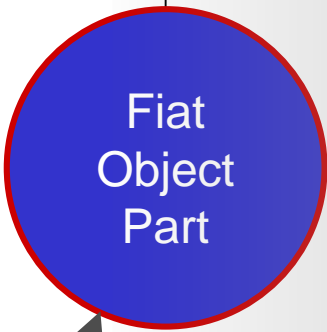
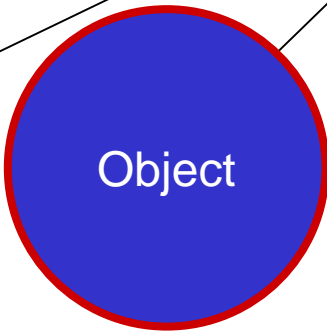
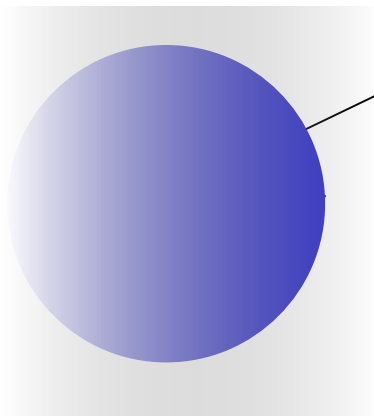
Lung Surface vs.
Pleural Space:
Bona Fide Boundary
(physical discontinuity)

Lung Hilus: Entry of
Bronchi, veins and
arteries.

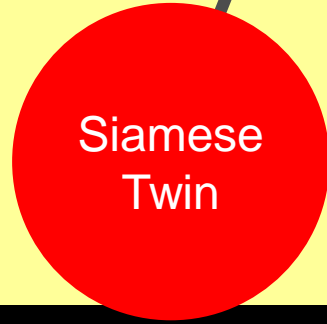
Fiat Boundary
(no physical discontinuity)

Object or FiatObjectPart?

BFO



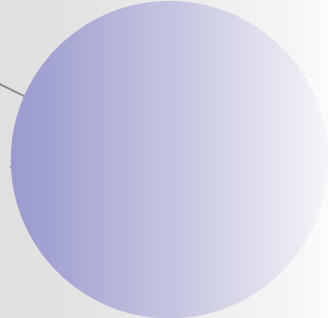
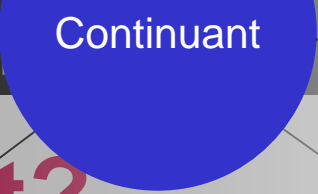
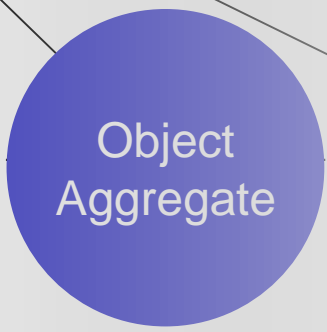
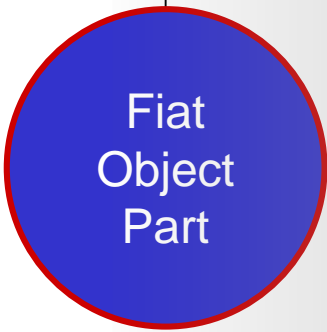
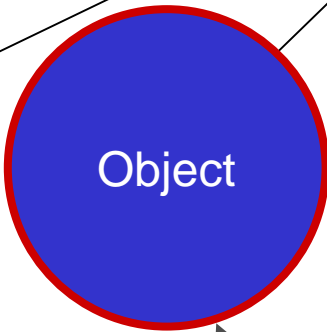
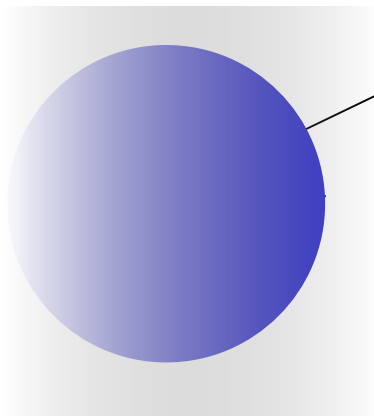
BioTop



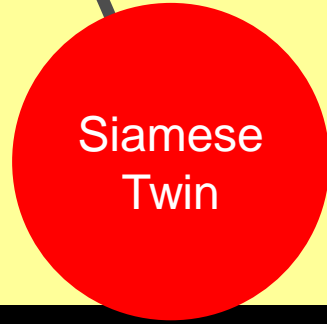
...before separation

Object or FiatObjectPart?

BFO



BioTop

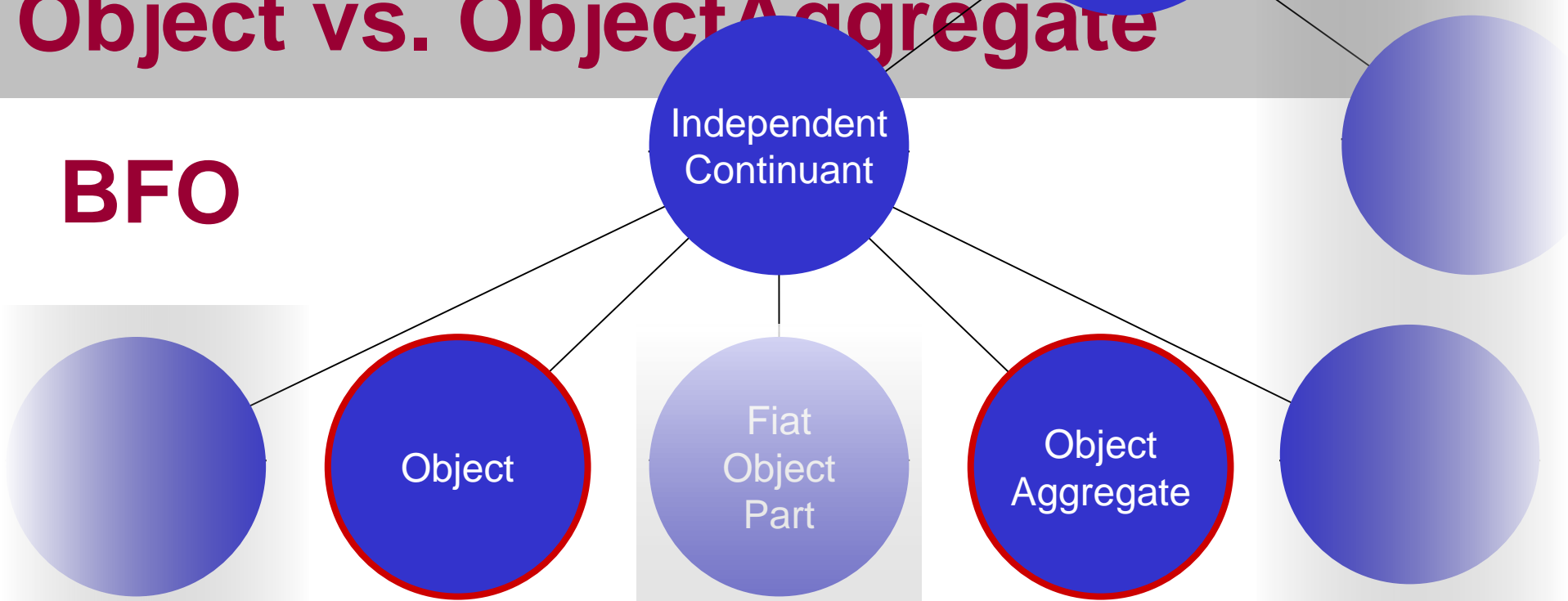


...after separation

Object vs. ObjectAggregate

Object vs. Object Aggregate

BFO



An independent continuant entity that is spatially extended, maximally self-connected and self-contained (the parts are not separated from each other by spatial gaps), and possesses an internal unity; the identity of substantial objects is independent of that of other entities and can be maintained through time and through loss and gain of parts and qualities.

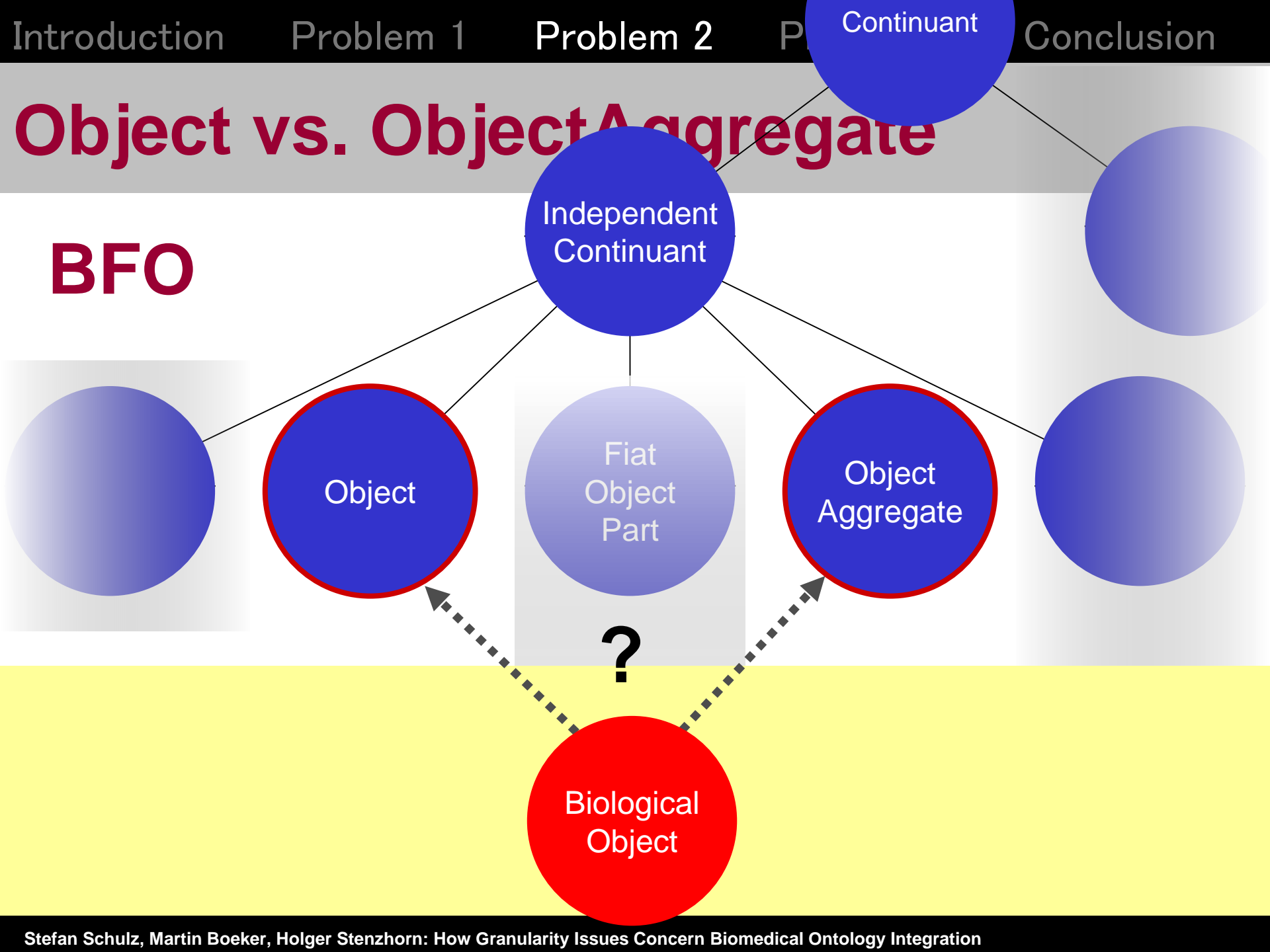
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Examples: *a heap of stones, a group of commuters on the subway, a collection of bacteria, a flock of geese, the patients in a hospital, a symphony orchestra.*

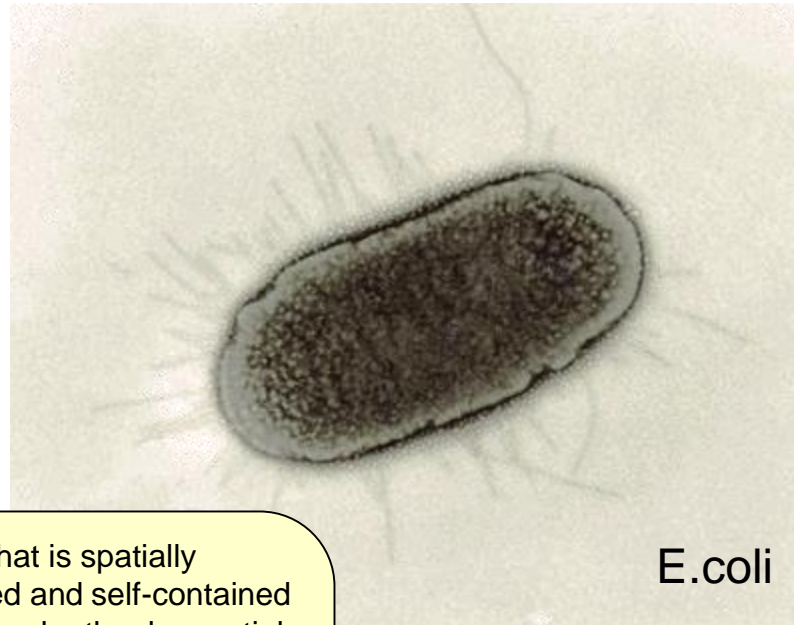
Object vs. Object Aggregate

BFO



Object vs. ObjectAggregate

Object

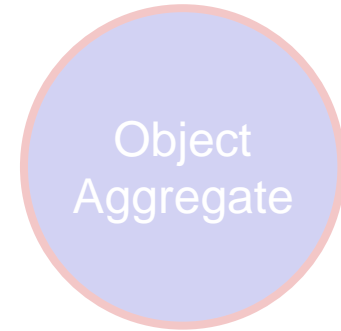
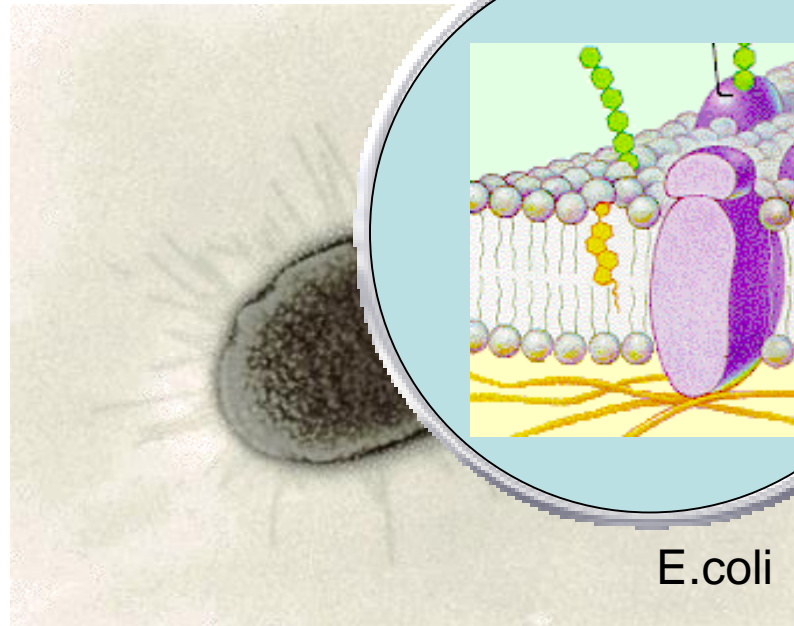
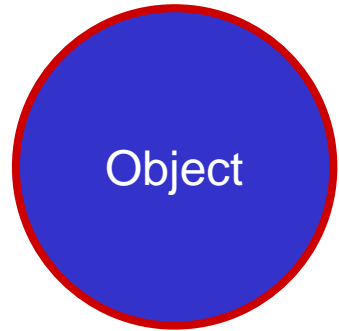


E.coli

An independent continuant entity that is spatially extended, maximally self-connected and self-contained (the parts are not separated from each other by spatial gaps), and possesses an internal unity; the identity of substantial objects is independent of that of other entities and can be maintained through time and through loss and gain of parts and qualities.

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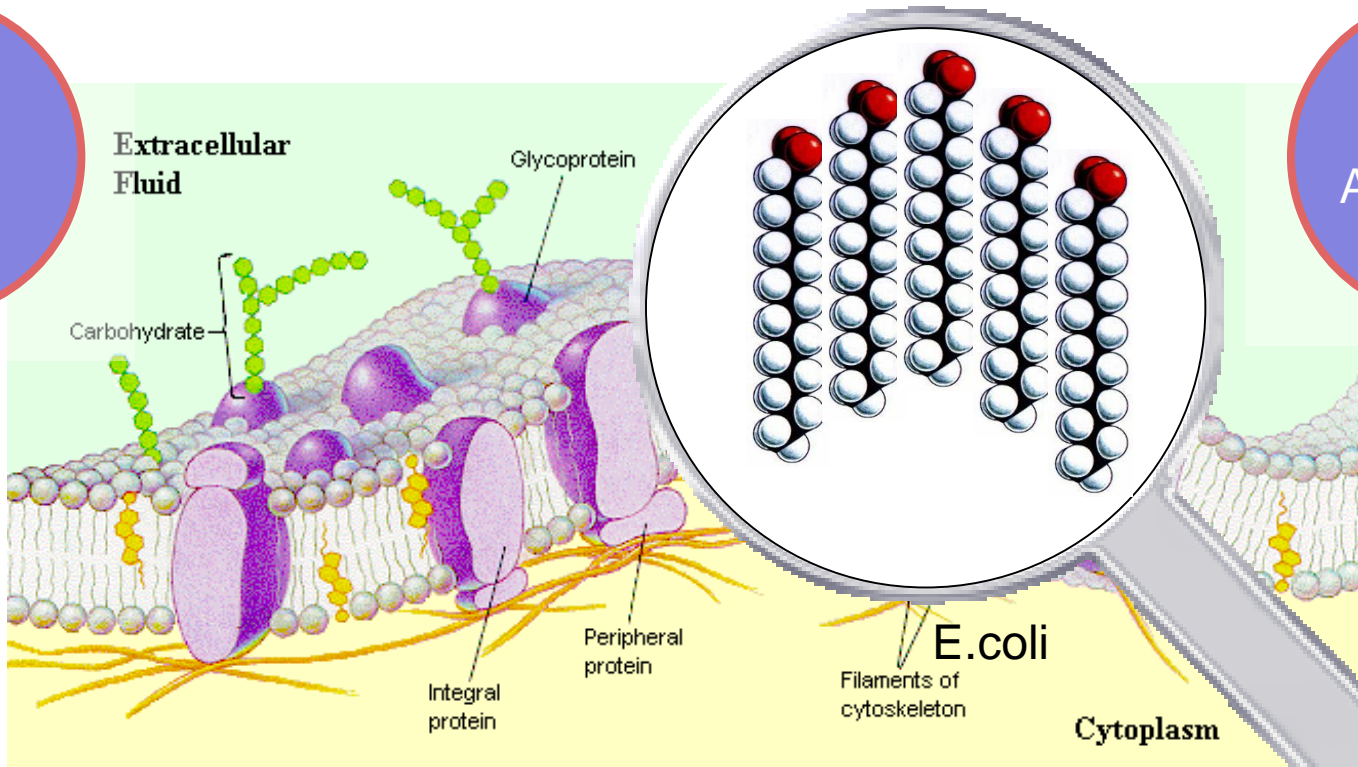
Object vs. ObjectAggregate



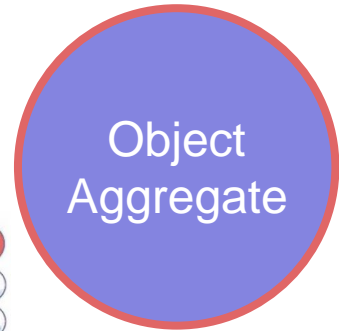
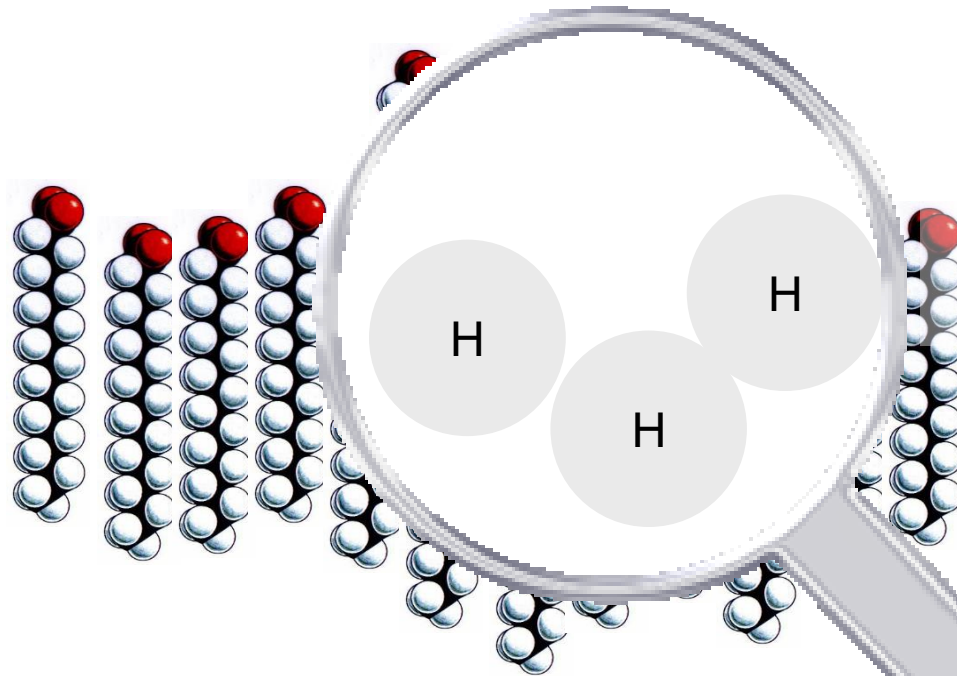
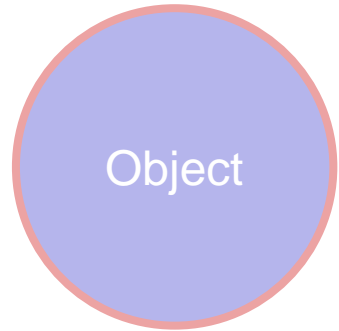
Object vs. ObjectAggregate

Object

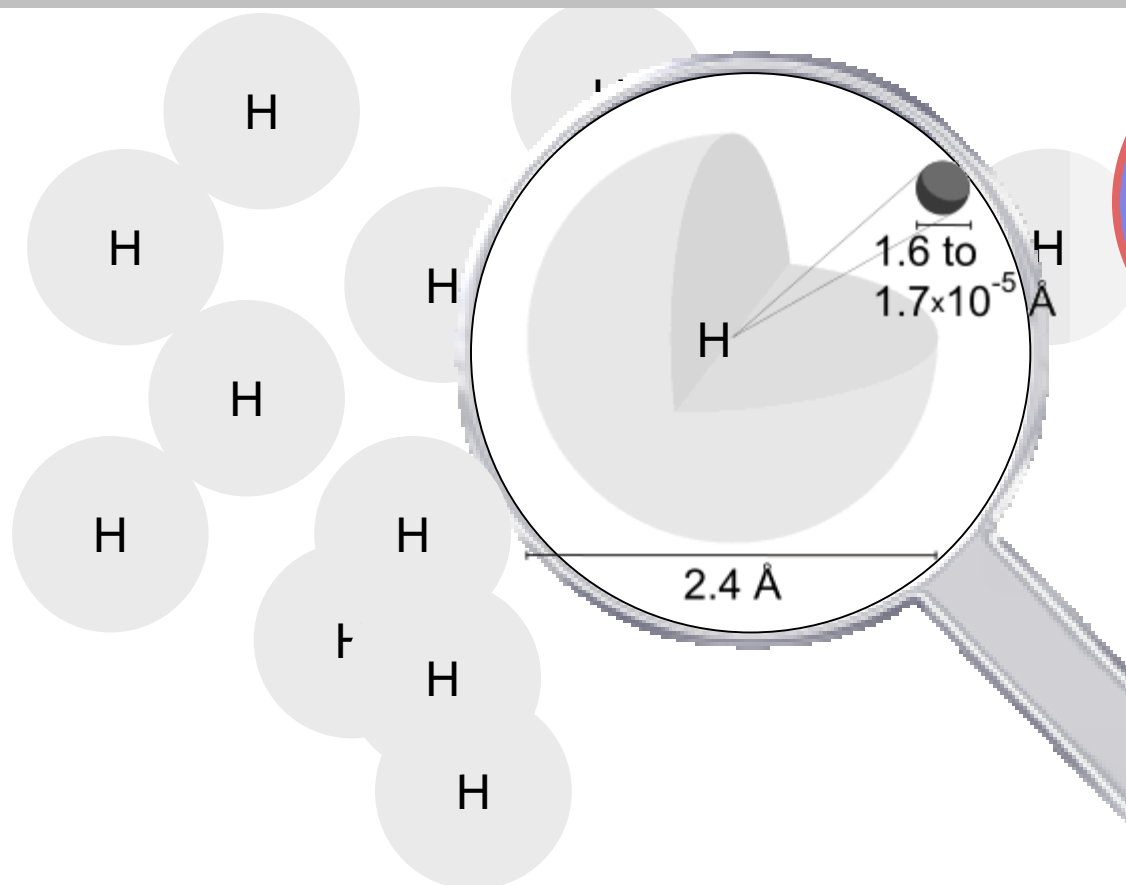
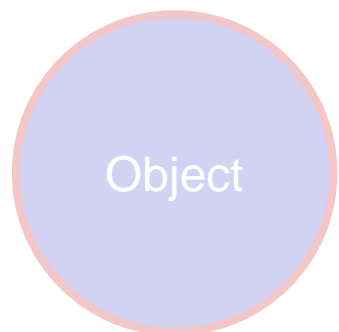
Object Aggregate



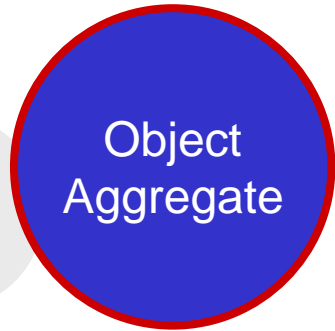
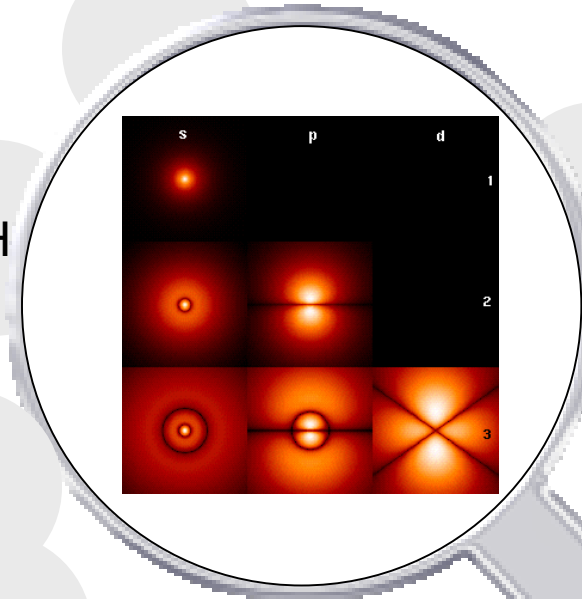
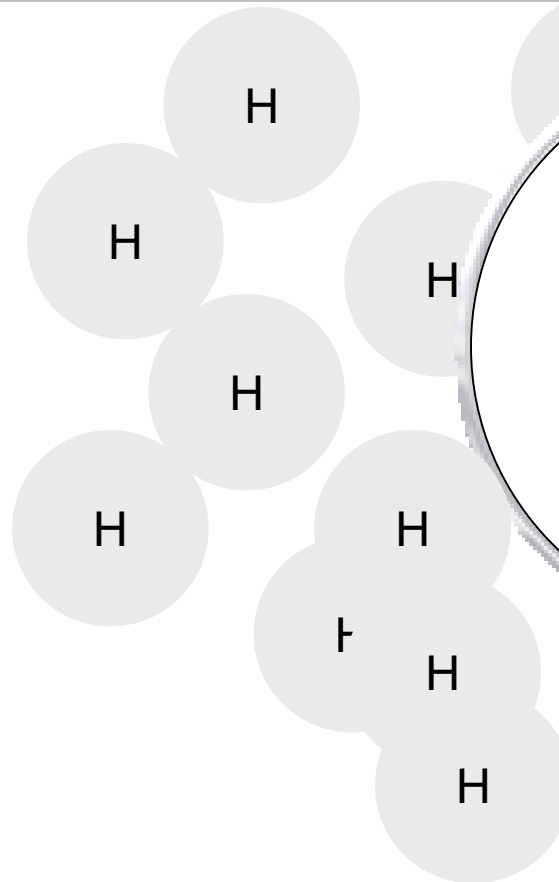
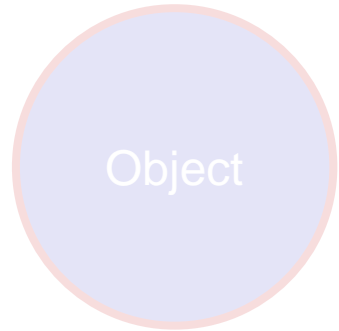
Object vs. ObjectAggregate



Object vs. ObjectAggregate!



Every Biological Object is an ObjectAggregate!



An independent
continuant entity that is
a mereological sum of
separate objects.

0,0001% nuclei
99,9999% empty space “filled”
by probability distributions of
electrons

Introduction

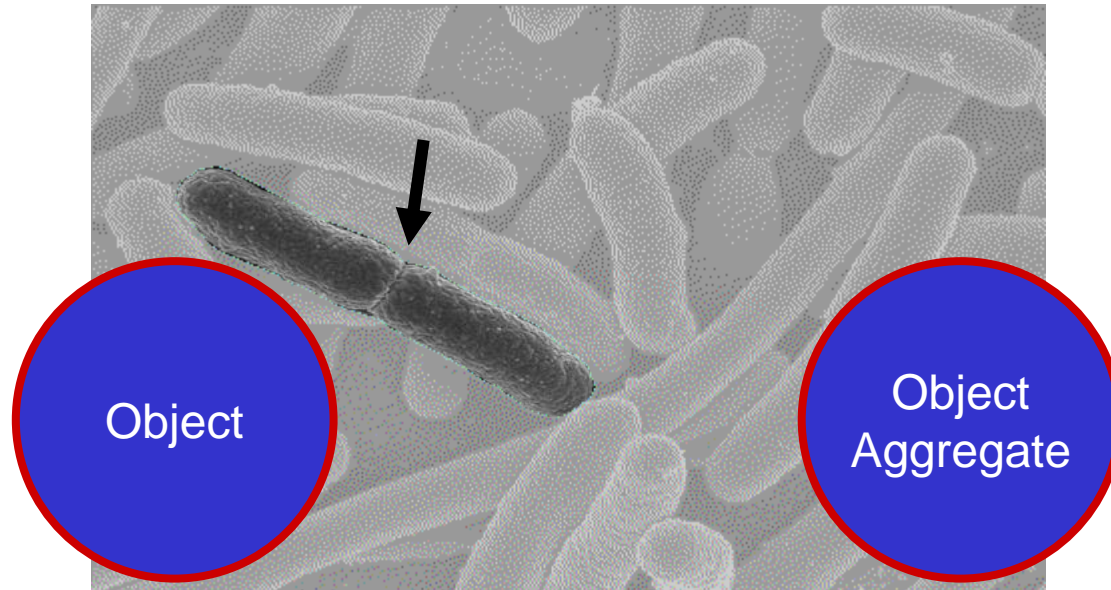
Problem 1

Problem 2

Problem 3

Conclusion

Problem 3: What are “separate objects”?



Object

Object
Aggregate

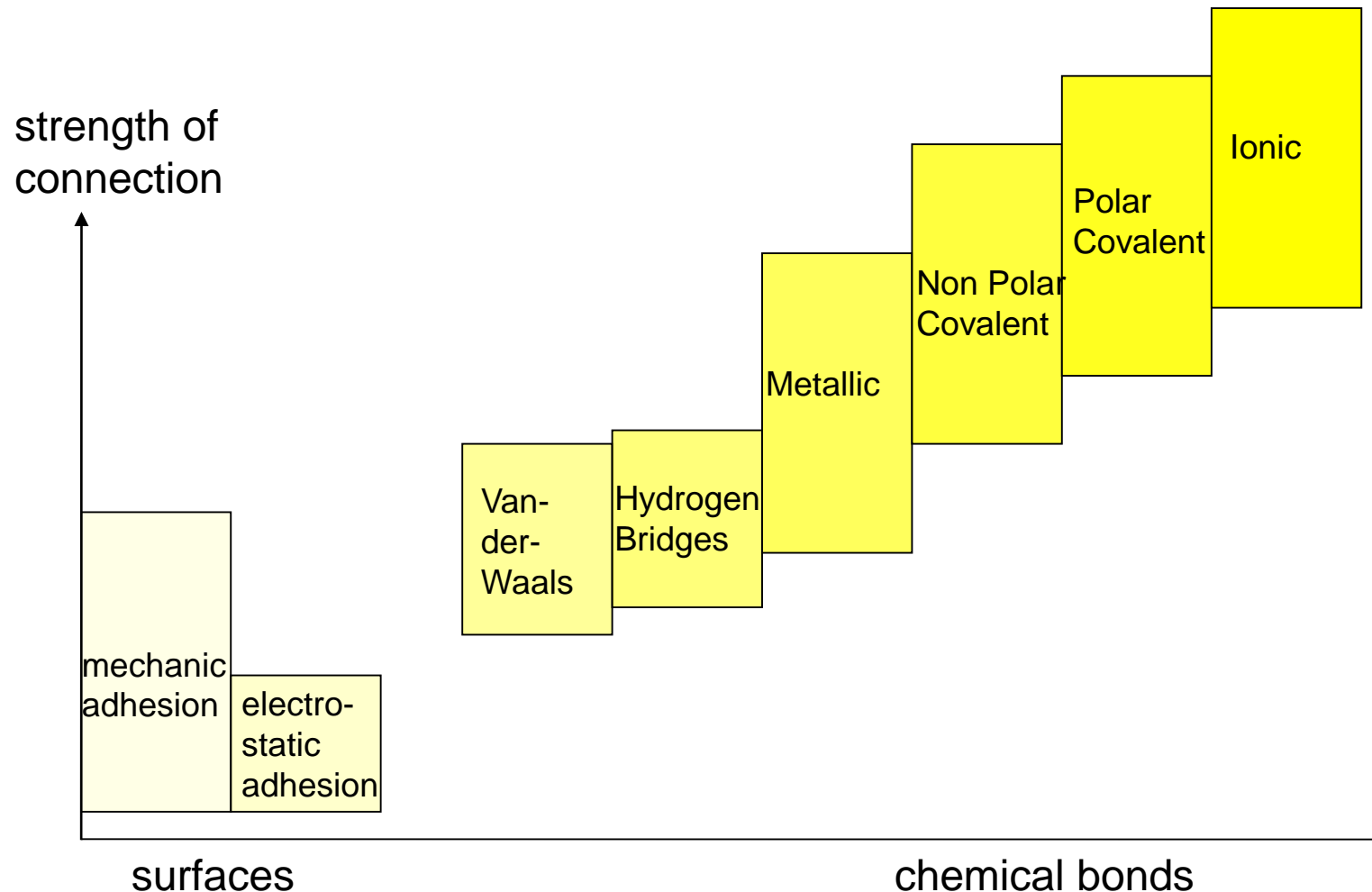
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Continuum of physical connection



Introduction

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Conclusion

BFO 3rd level categories challenged by

- Granularity-dependent notion of self-containedness and unity of objects
- Granularity-dependent view of objects as collection of particles
- Continuum of physical connection
- BFO uses ill-defined criteria of highest-level ontological distinctions

Consequences for upper ontology integration

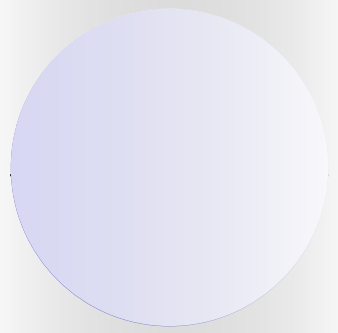
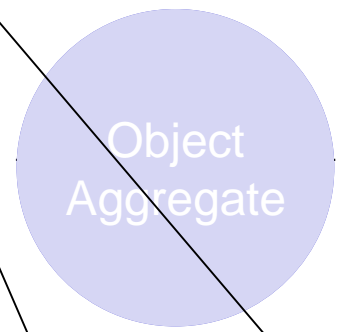
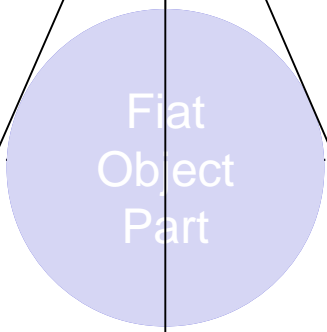
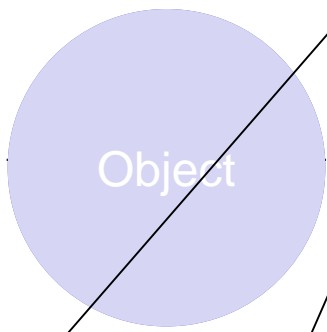
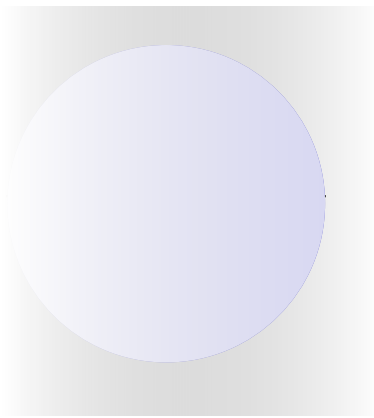
- Critique of domain level ontology (BioTop) by applying the rigor of an upper level ontology
- Critique of the upper level ontology by assessing the appropriateness of upper level categories from the perspective of the domain level
- Practical conclusion for BioTop: exclude subclasses of BFO:IndependentContinuant

Consequences for upper ontology integration

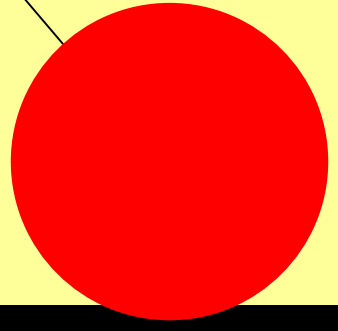
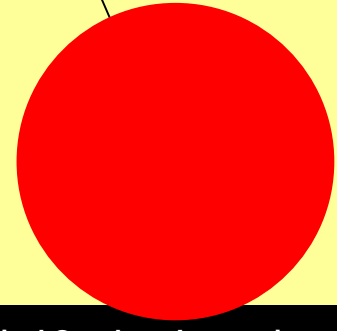
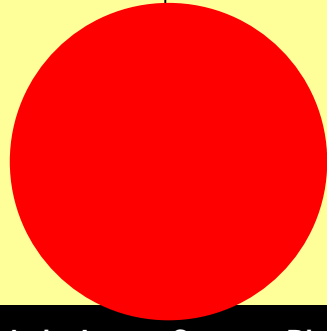
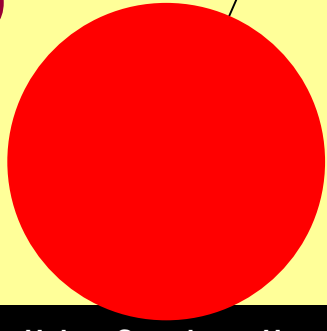
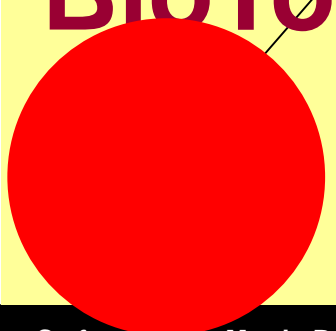
BFO



Conclusion

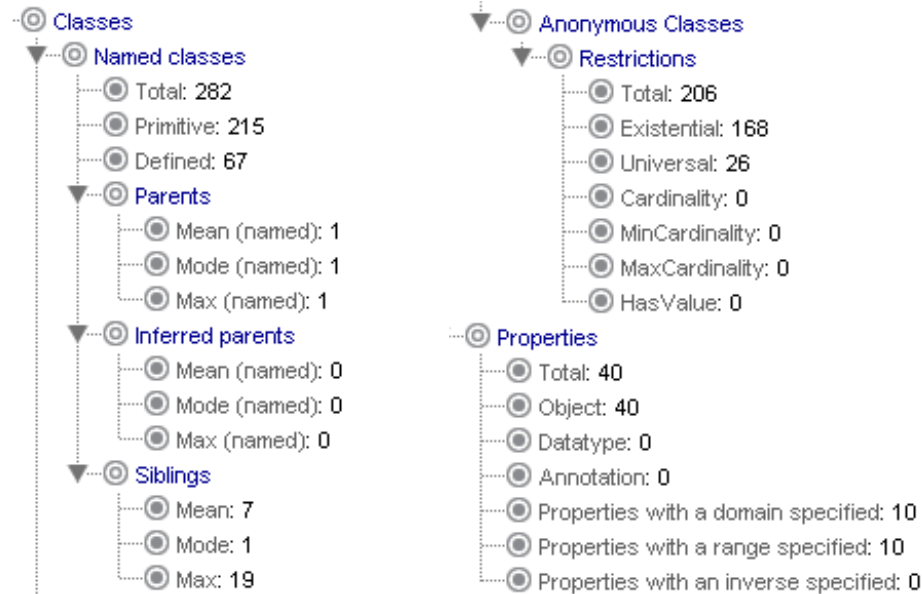


BioTop



BioTop

- Metrics:



- BioTop is freely available at: <http://purl.org/biotop>
- BioTop discussion forum: biotop@googlegroups.com
- BootSTREP (FP6 - 028099) project: <http://www.bootstrep.eu>

