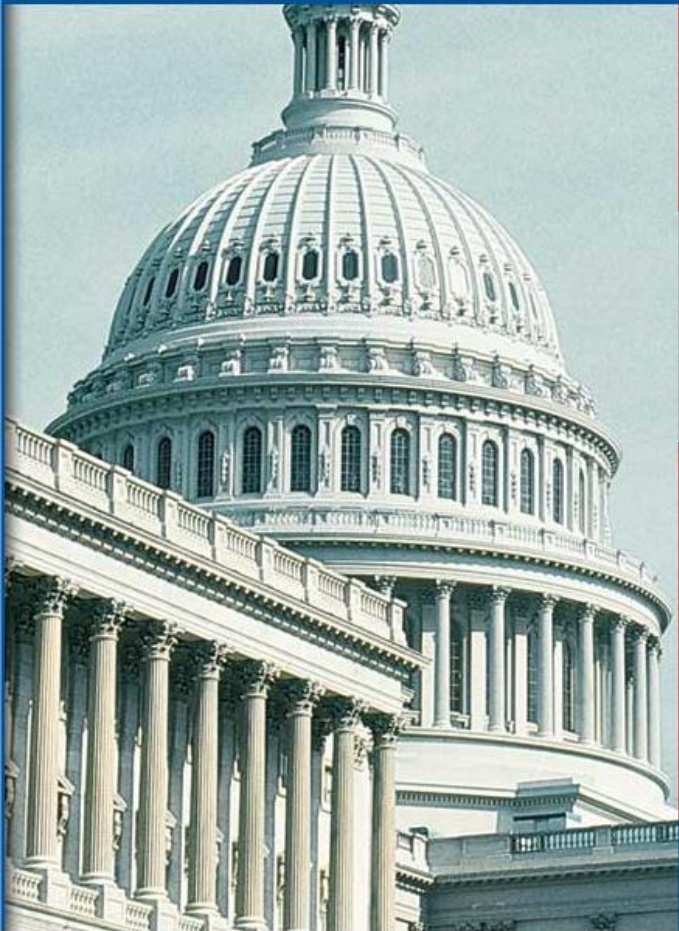


American Medical Informatics Association



Annual
Symposium



Biomedical and
Health Informatics:

From Foundations
to Applications
to Policy

October 22-26, 2005
Hilton Washington and Towers
Washington, DC

AMIA Workshop WP06 Ontological Foundations of Biomedical Terminology Systems

Organized by AMIA WG
Formal (Bio)Medical Knowledge
Representation

Washington, DC, 10/22/2005

History

- 2002: Ronald Cornet / Stefan Schulz: Idea of foundation of a SIG on Ontologies / Knowledge Representation
- 2003: SIG “Formal (Bio)Medical Knowledge Representation. Approval by AMIA, Kick-Off Meeting at AMIA 2003. KR-SIG Mailing List
- 2004: KR-MED 2004 in Whistler (Canada)
- Panel at MEDINFO
- Upgrade SIG -> WG
- 2005: Intensive e-mail discussions on basic notions of terminology / ontology building, draft of a AMIA paper “Six questions on ontology building” (not accepted)
- AMIA Workshop submission. Purpose of workshop: To stimulate and intensify the discussion on formal and philosophical foundations of biomedical ontologies.
- Plan for 2006: Write a WG position paper -> JAMIA
- Tuesday 5:15 p.m. Business meeting of the WG: Thoroughbred room, Concourse level.

Workshop WP06

Ontological Foundations of Biomedical Terminology Systems

Topic	Presenter	Duration (min)
Introduction	Stefan Schulz	5
1. Resolving ambiguities in current uses of the term "concept"	Barry Smith	15 + 5 (Q&A)
2. Do divergences in philosophical thinking (Realism, Conceptualism, Nominalism) have implications the concrete tasks of ontology engineering in the biomedical domain?	Stefan Schulz	15 + 5 (Q&A)
3. Should the term 'ontology' be used in a broad sense which does not exclude any of those artifacts commonly referred to as 'biomedical vocabularies' in the medical informatics community?	Ronald Cornet	15 + 5 (Q&A)
4. Discussion on the basis of the three talks	Led by Ira Kalet	10
Break		5
5. How can ontologies, which deal with relations between universals, be made interoperable with the electronic health data, which deal with instances of such universals?	tbd.	15 + 5 (Q&A)
6. Facilitation of ontology creation by human curators using statistical and lexical approaches	Olivier Bodenreider	15 + 5 (Q&A)
7. Difference between pre and post-coordinated ontologies and its implications on single and multiple inheritance. Should the design of formal ontologies be guided by concrete recommendations, e.g., single inheritance, avoidance of negative classes, pairwise disjoint siblings, jointly exhaustive siblings?	Anand Kumar	15 + 5 (Q&A)
Wrap-up	Ronald Cornet	10



**Realism, Conceptualism, Nominalism
and their Impact on Biomedical
Terminologies / Ontologies**



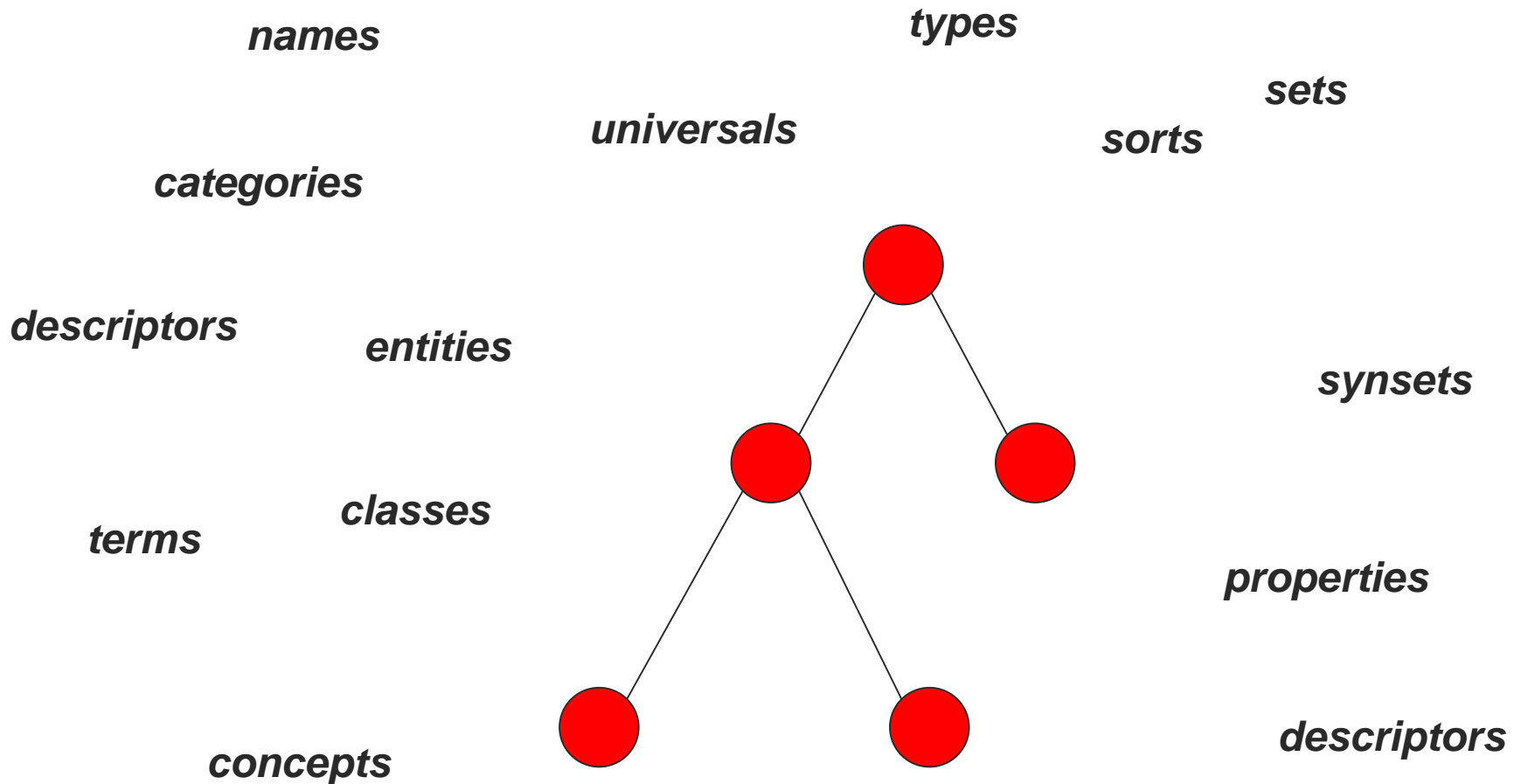
Realism, Conceptualism, Nominalism and their Impact on Biomedical Terminologies / Ontologies

as naïvely understood by non-philosophers...

Stefan Schulz
Martin Boeker

Freiburg University Hospital (Germany)

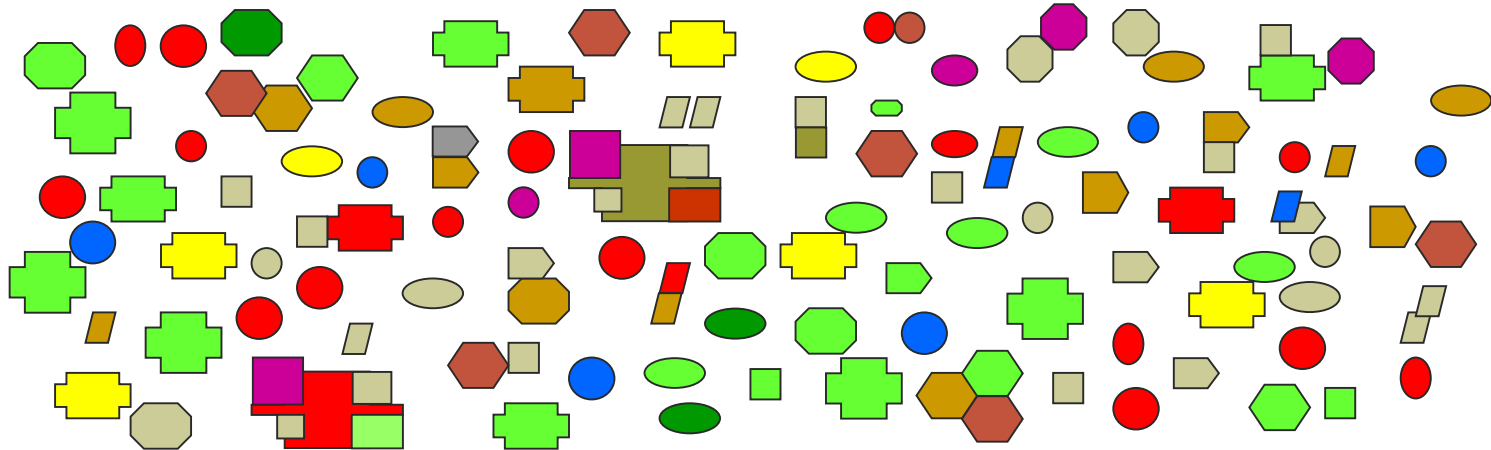
What do the nodes in biomedical terminology systems stand for?



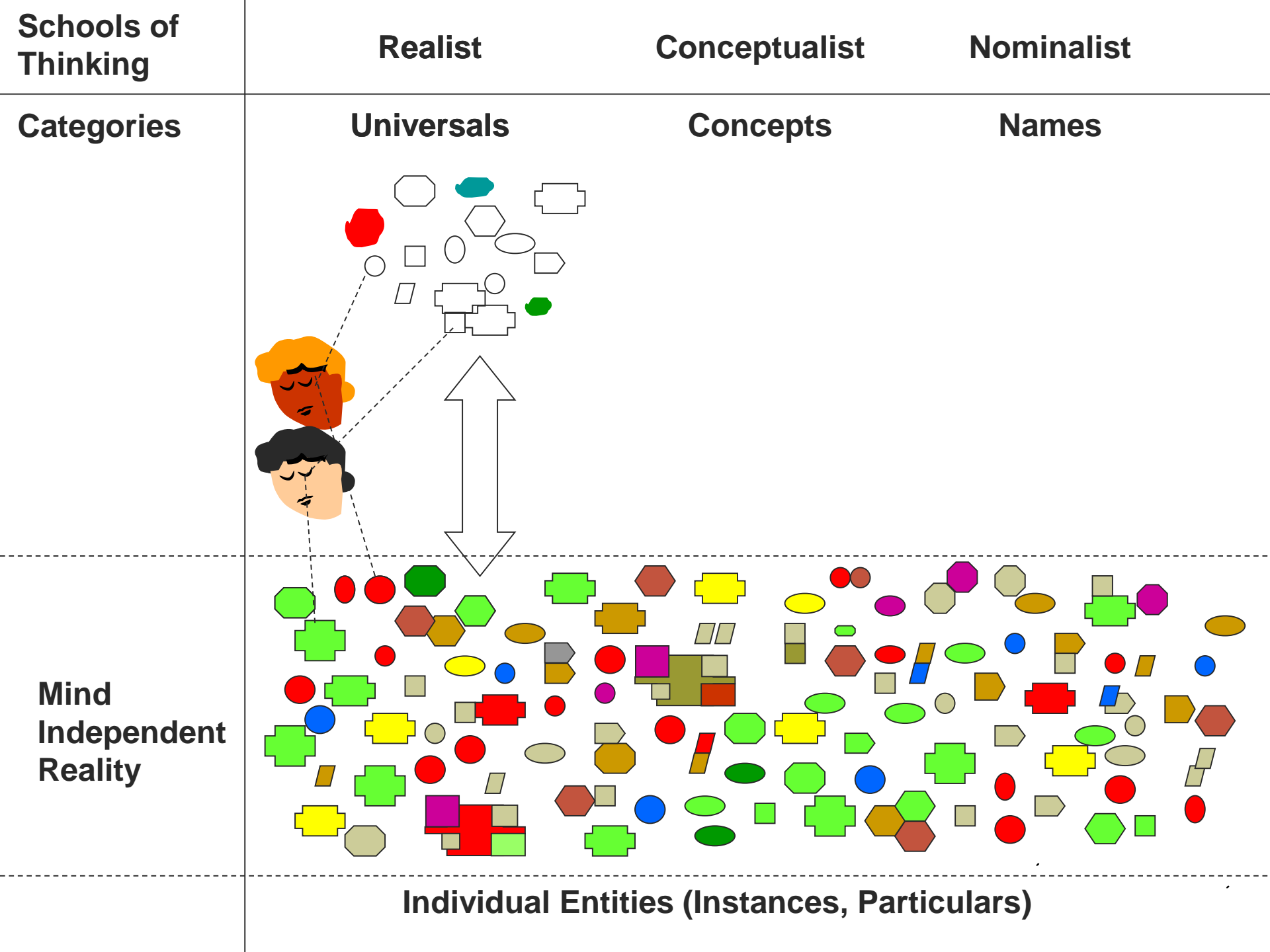
Terminological Confusion

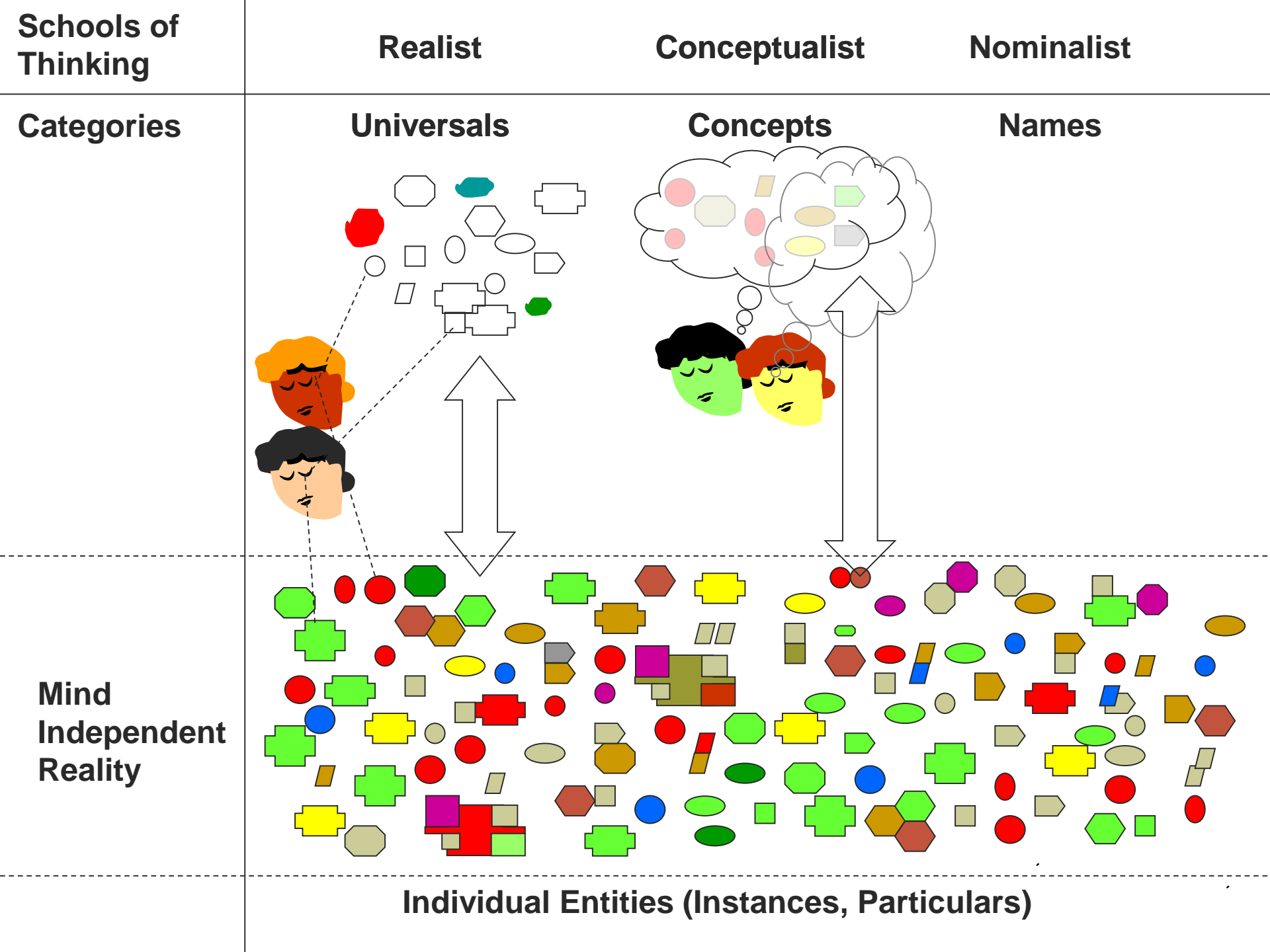
- Different scientific traditions (Logics, Computer Science, Library and Information Science, Cognitive Science, Linguistics,...)
- Different philosophical schools of thinking: (Platonism, Aristotelian Realism, Conceptualism, Relativism, Idealism, Postmodernism, Constructivism, Nominalism, Tropism,...)
- Is there a common ground which suits the needs of Biomedical terminology / ontology construction ?

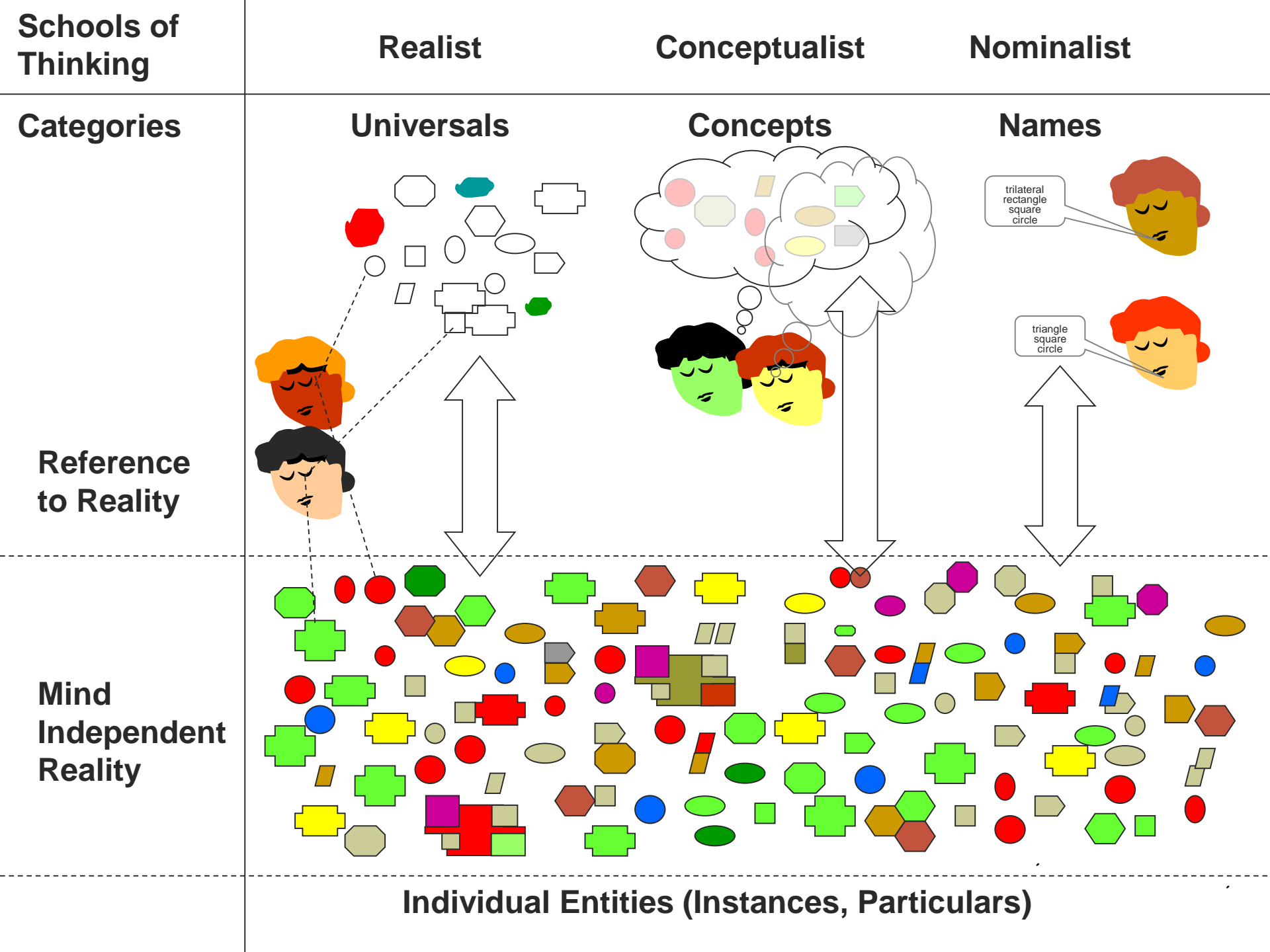
**Mind
Independent
Reality**



Individual Entities (Instances, Particulars)

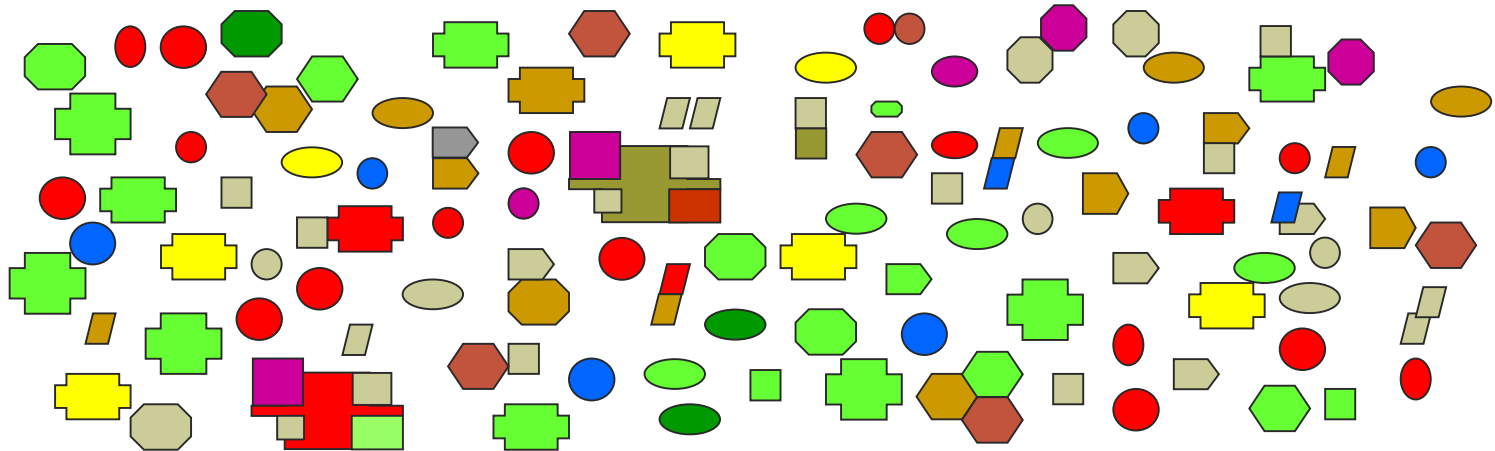






Ordering / Organizing Reality

- Two approaches:
 - Delimitation of individual entities: identifying aggregation as mereological sums of atomic individuals
 - Classification: ordering individuals: assignment to classes

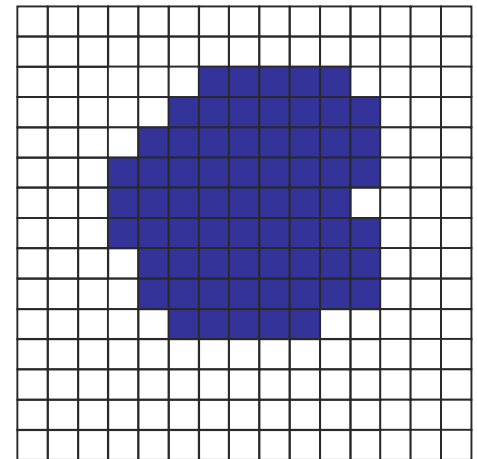


Individual Entities (Instances, Particulars)

Delimitation of Individual Entities

Problem: which chunks of matter / sum of atoms are considered valid composite entities?

- Realist: composition / delimitation of individual entities as pattern of being
- Conceptualist / nominalist: composition / delimitation of individual entities as result of human cognition or decision (“fiat”)

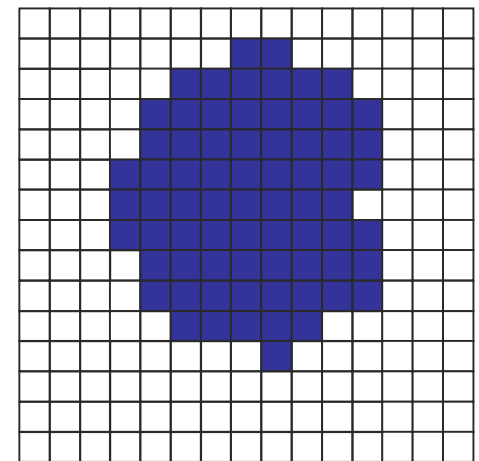


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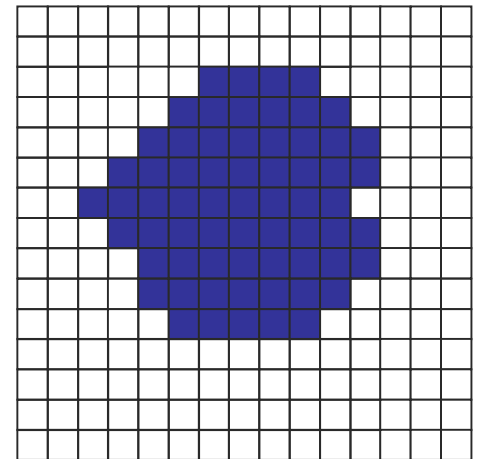


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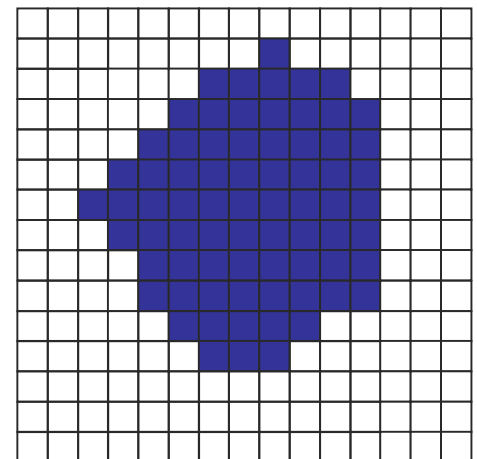


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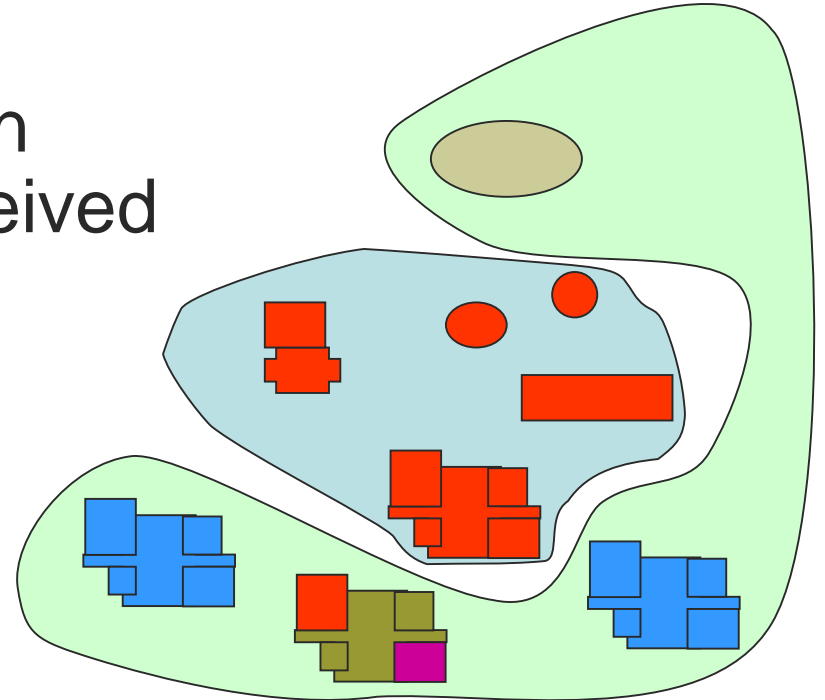


Individual Entity

Delimitation of Classes

Problem: which individual entities belong to the same class?

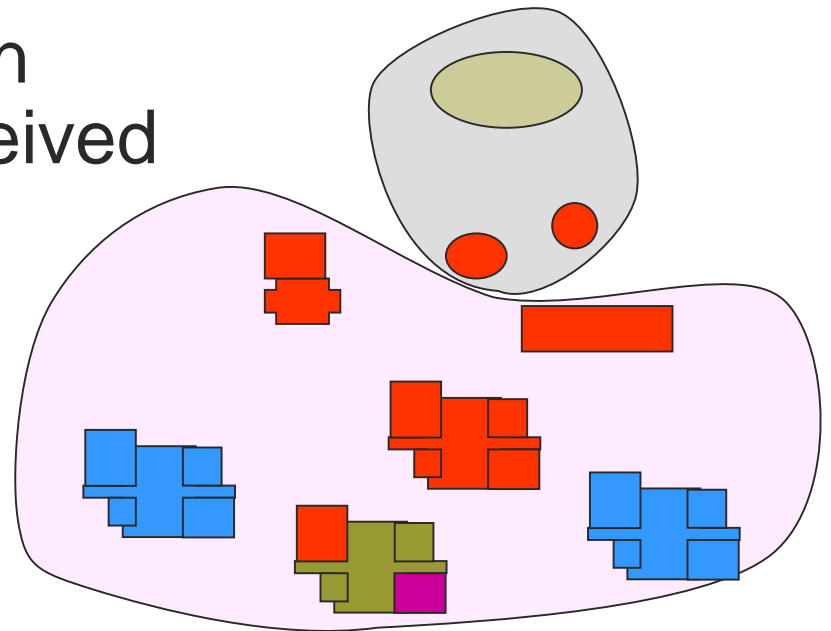
- Realist: class membership as invariant pattern of being (instantiation of universals)
- Conceptualist: class membership as extension of a concept due to perceived similarities
- Nominalist: given name as criterion for class membership (strict N.: denial of classes)



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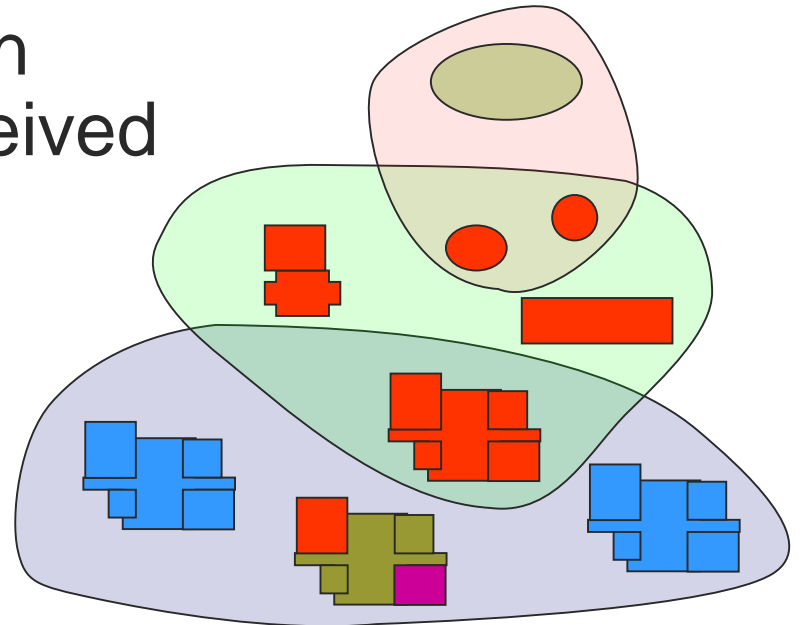
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Theoretical Upper Bound of number of individuals and classes

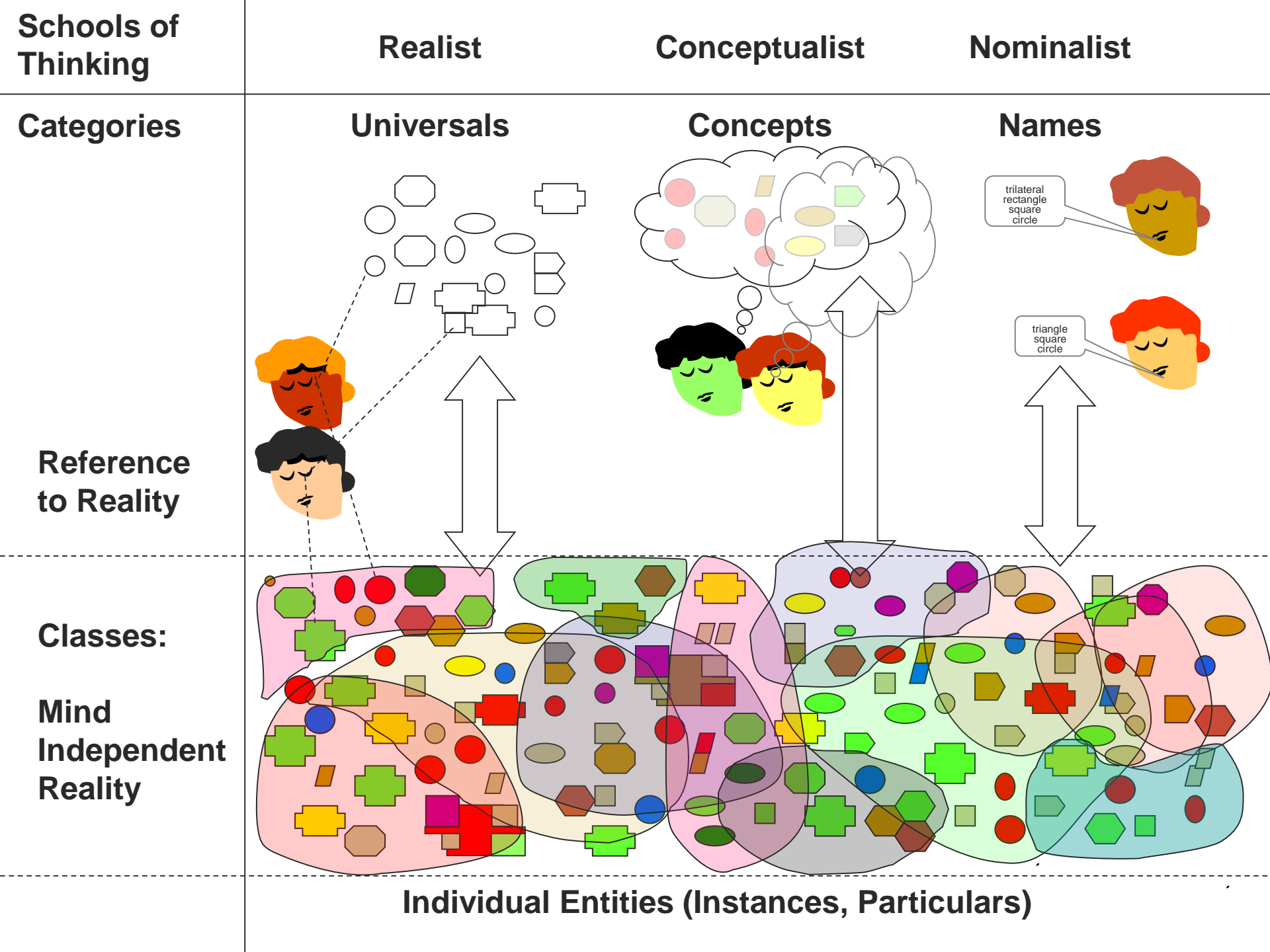
- n atoms in reality: $m = 2^n - 1$ possible entities (arbitrary aggregations), candidates for individuals / particulars
- entities: $2^m - 1 = 2^{2^n - 1} - 1$ different classes: possible extensions of universals, concepts, or names

Atoms	Individuals	Classes
1	1	1
2	3	7
3	7	127
4	15	32767
5	31	2147483647
6	63	9,22337E+18
7	127	1,70141E+38
8	255	5,7896E+76
9	511	6,7039E+153
10	1023	8,9885E+307

99,9999999999..%
of these individuals and
classes are completely
irrelevant

[Which classes are relevant...]

... and correspond to the extension of
universals, concepts or names ?



[Realism:

Classes as extensions of Universals:]

- All universals refer to non-empty (at some moment) classes
- New classes can be created by common set theoretical operations, e.g. disjunction, negation, complement.
- Many of those classes do not correspond to a universal, e.g. “*invertebrate*”, “*wound infection NEC*”, ... but such classes are nevertheless useful, e.g. in order to guarantee disjoint clinical classifications

Conceptualism:

Classes as extensions of Concepts:

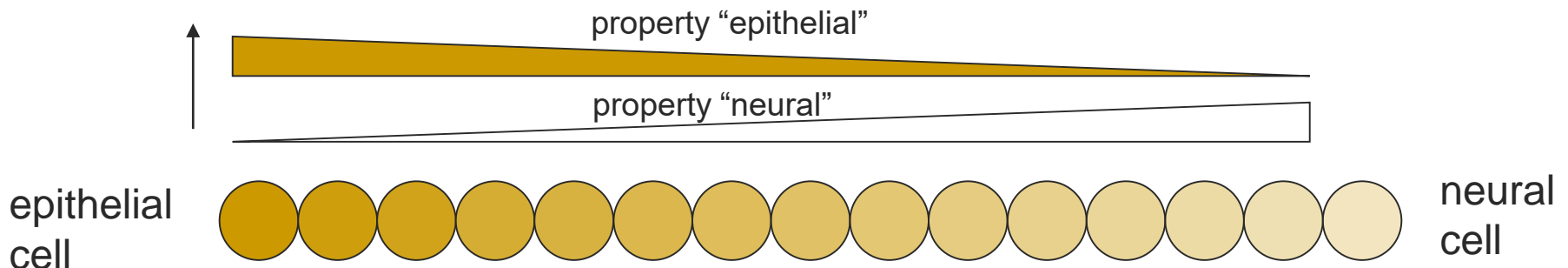
- Unlike universals, concepts do not necessarily imply the extension to classes in reality (“*retinal transplant*”, “*yin deficiency*”, “*missing digit*”, “*prevented pregnancy*”)
- Concepts as entities of thought may mix ontological and epistemological aspects: “*Cirrhosis of liver without mention of alcohol*”
- Concepts as mind constructs may be oriented to prototypes, their extension exhibits large inter-individual variation (deviation from prototype)

Nominalism: Classes as extensions of natural language expressions

- Classes are built in an ad hoc fashion from linguistic predicates.
- Examples:
 - *People in Room Monroe West at 8pm on October 22, 2005*
 - *“Extraction of Foreign Body from Stomach by Incision”*

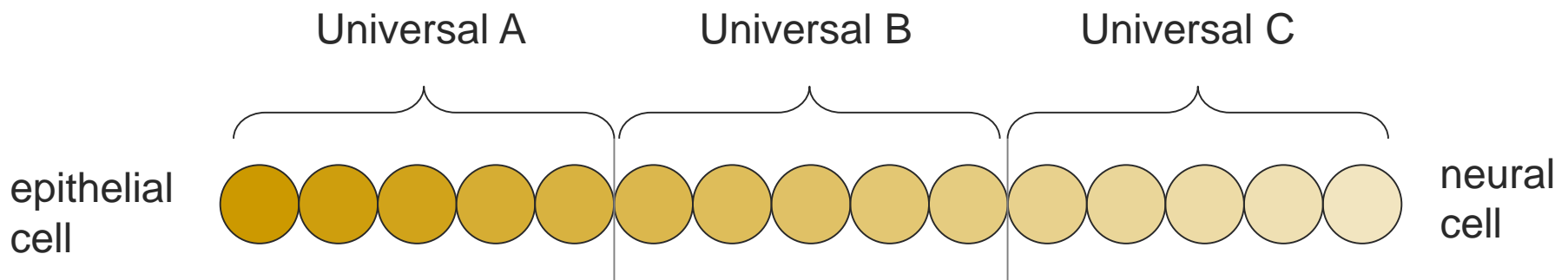
Universals and Continua

- The realist approach is most striking when applied to individuals which show crisp “bona fide” distinctions and which are easy to classify, especially atoms and molecules
- It runs into problems where the properties individuals exhibit lie on a continuum, which is the case with many biological objects.



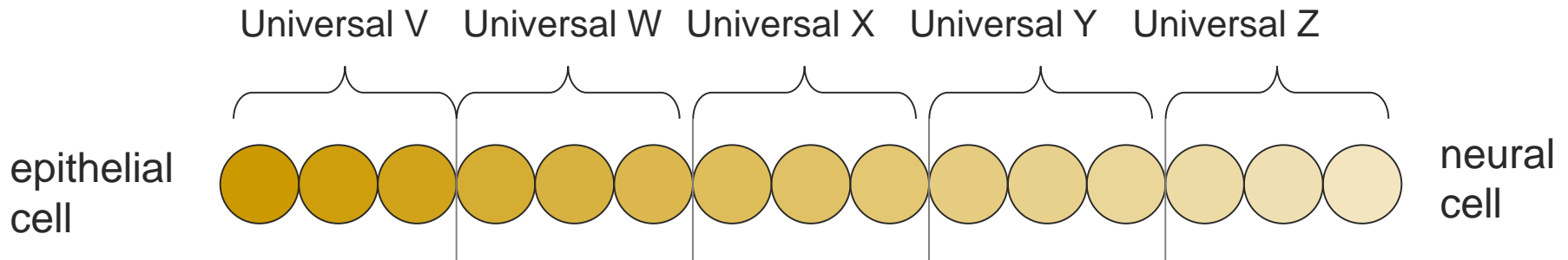
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Conclusions

- Most terminology builders and users have a implicitly promiscuous attitude towards philosophical categories
- Impossible to reach agreement on overly purist approaches
- There may be reasons for hybrid use of universals, concepts, and names in biomedical terminologies
- Talking about “classes of individuals” may be the best common denominator which allow bridging between different standpoints.
- Nevertheless, awareness of philosophical / logical background should be raised among terminology builders and users

Nominalism: Classes as extensions of natural language expressions

- Classes are built in an ad hoc fashion from linguistic predicates. Example: “*Extraction of Foreign Body from Stomach by Incision*”

RemovalOfForeignBodyFromDigestiveSystem AND

RemovalOfForeignBodyFromStomach AND

IncisionOfStomach AND

\exists has-part. (\exists *Method.RemovalAction AND*

\exists *DirectMorphology.ForeignBody*) *AND*

\exists has-part. (\exists *Method.IncisionAction AND*

\exists *ProcedureSite.stomachStructure*)