The
International
Association for
Ontology and
its Applications

Computational Ontologies and their Logical Models

Nicola Guarino
Retired research associate, ISTC-CNR Laboratory for Applied Ontology, Trento
www.loa.istc.cnr.it

ESAO Launch Day, September 10, 2021

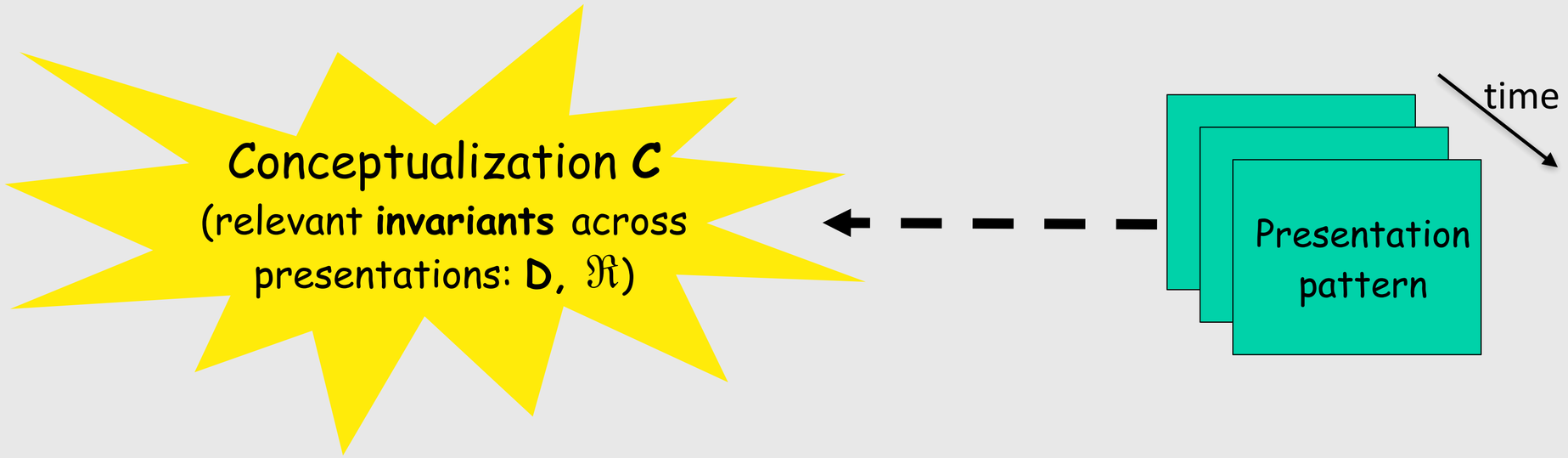
What are computational ontologies

A computational ontology is a specific artifact
expressing the ***intended meaning*** of a ***vocabulary***
in a machine-readable form

Gruber (93): “An ontology is an explicit and formal specification of a conceptualization”

If we use logic for such formal specification, this means that an ontology is a collection of ***meaning postulates*** (Carnap 1952)

From experience to *conceptualization*

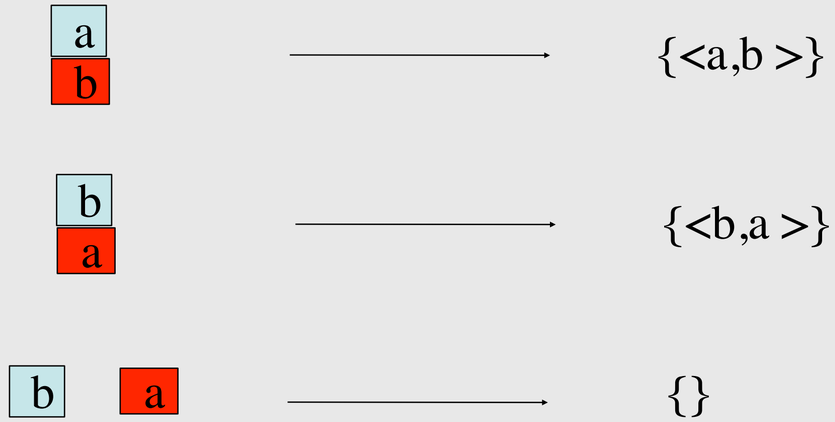


D : cognitive domain

ℜ : set of *relational concepts* on elements of **D**

Concepts as functions that point to cognitively relevant relations in all possible arrangements of *D*

The concept *red*

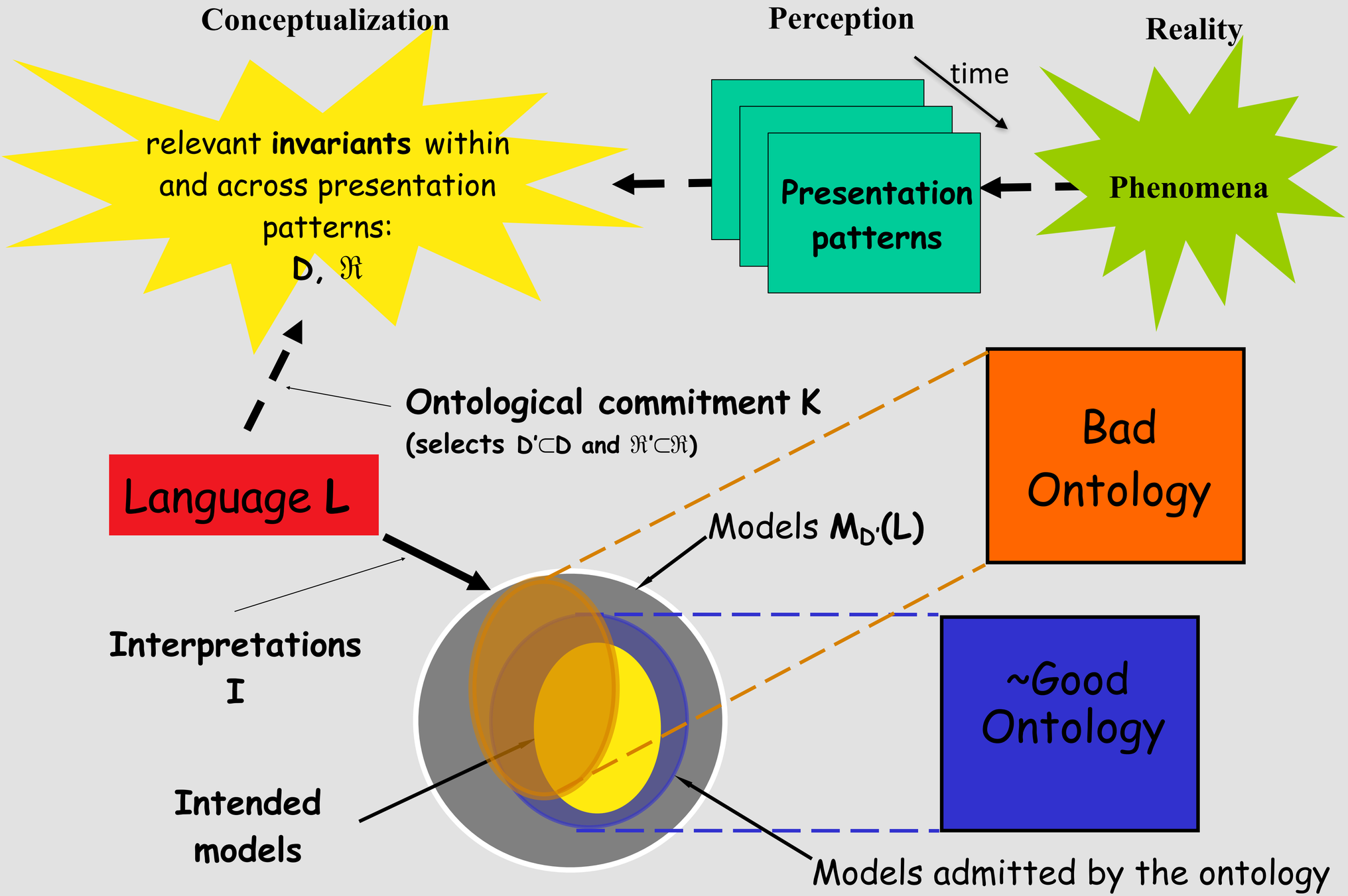


The concept *on*

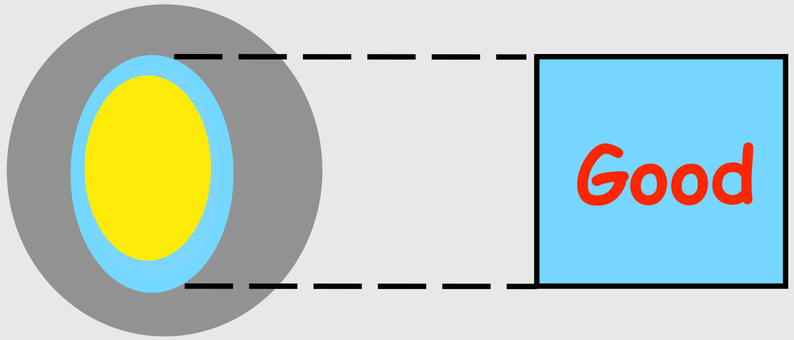
Examples of meaning postulates

- *If something is **black** it is not **red***
- *If a **person** is a **bachelor** such **person** is not **married***
- *If x is **on** y then y is not **on** x*

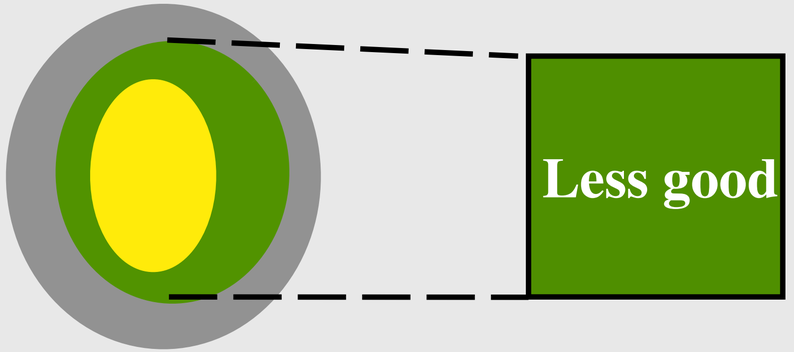
Meaning postulates ***make explicit*** the intended meaning of terms, while constraining the possible interpretations of the language, i.e., its ***intended models***


Conceptualization
Perception
Reality
time
relevant **invariants** within and across presentation patterns:
D, ℜ
Presentation patterns
Phenomena
Ontological commitment K
(selects D'⊂D and ℜ'⊂ℜ)
Language L
Models $M_{D'}(L)$
Bad Ontology
Interpretations I
~Good Ontology
Intended models
Models admitted by the ontology

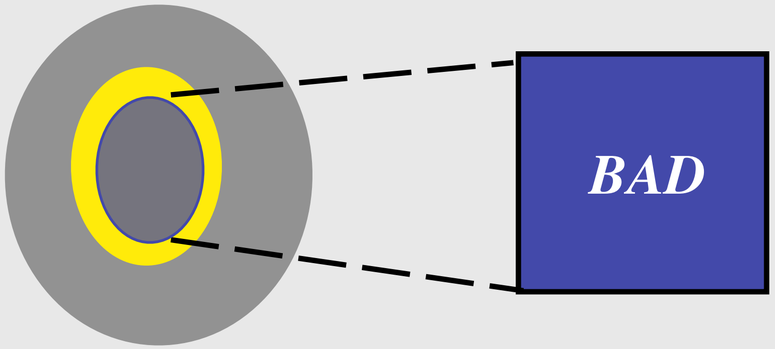
Admitted Models vs. Intended models: Precision and Correctness



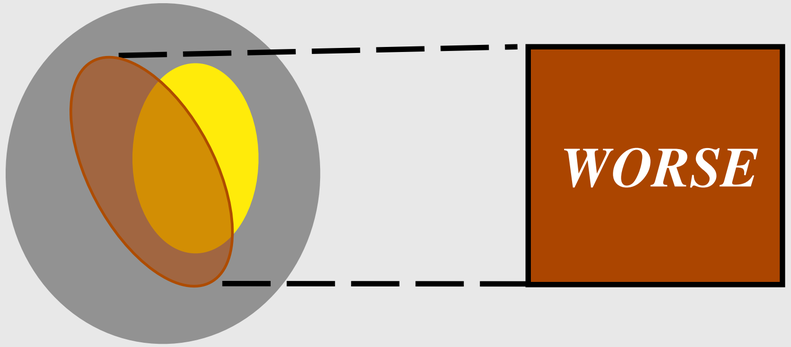
1. High precision, max correctness



2. Low precision, max correctness

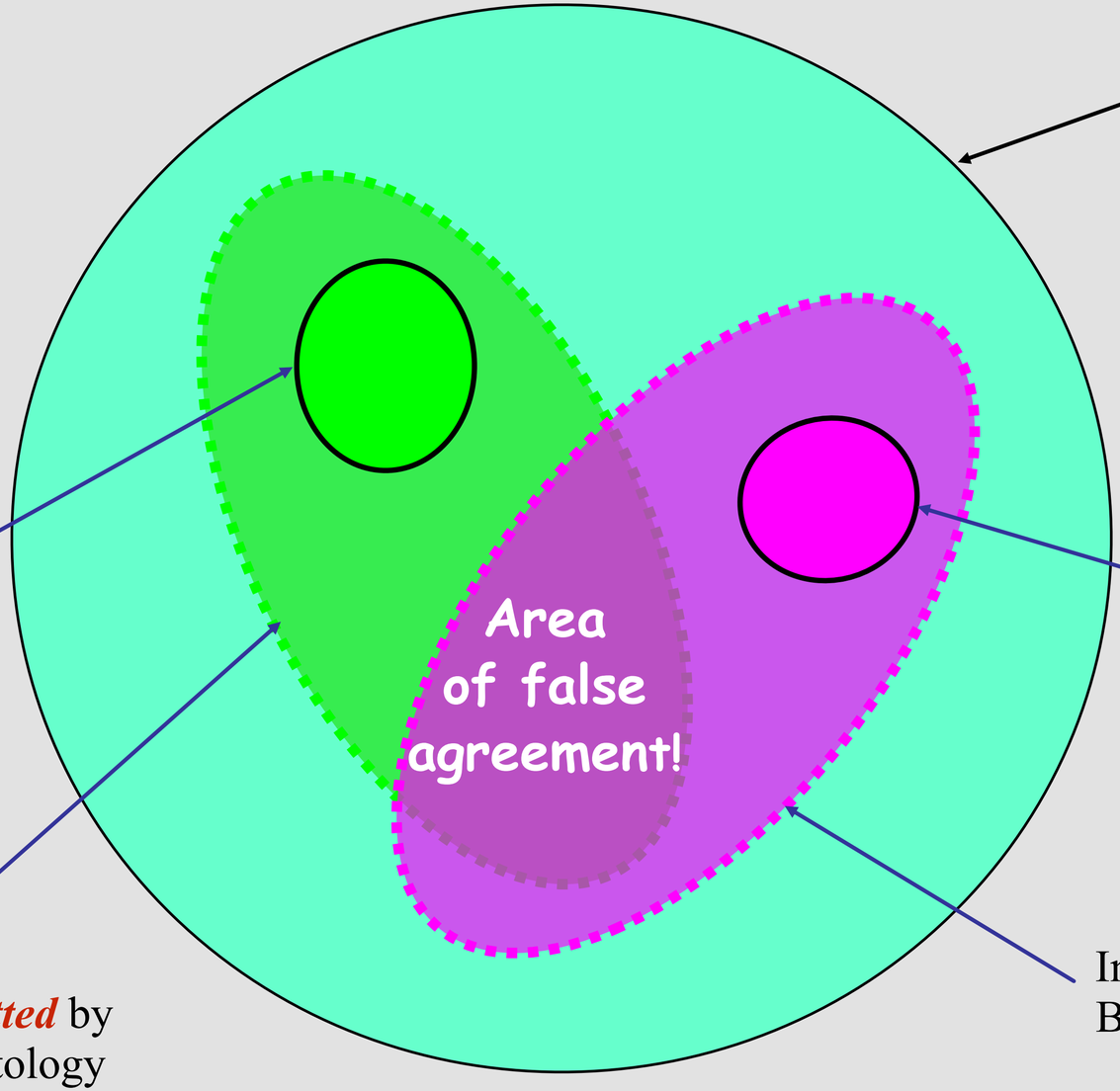


3. Max precision, low correctness



4. Low precision, low correctness

Why ontological precision is important



All interpretations of
"service"
(highly *overloaded* term!)

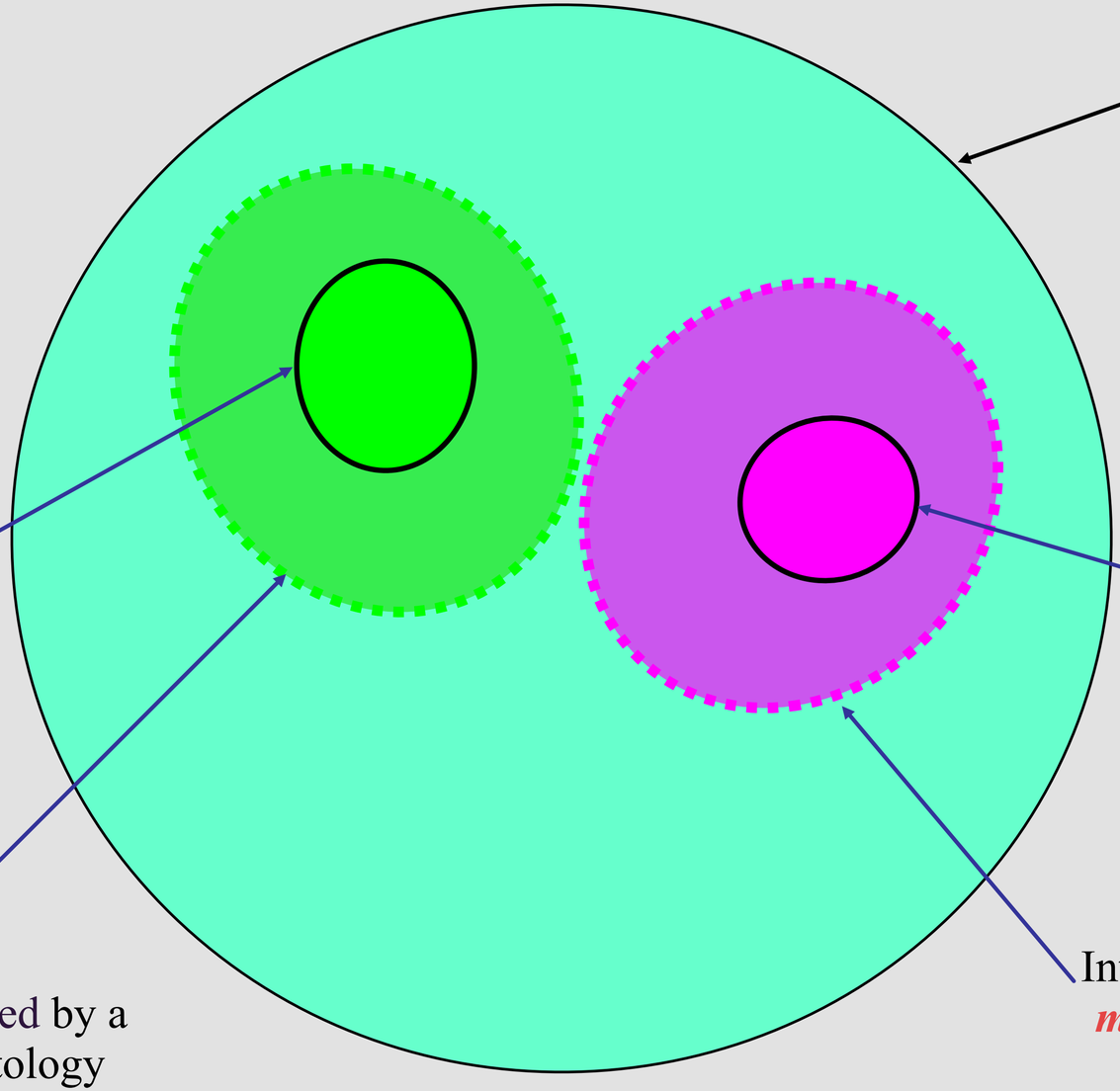
Agent A:
Intended interpretation
of **service as a commitment**

Agent B:
intended interpretation of
service as an action

Interpretations ***admitted*** by
A's (lightweight) ontology

Interpretations ***admitted*** by
B's (lightweight) ontology

What a few extra axioms can do



All interpretations of
“service”
(highly *overloaded* term!)

Agent A:
Intended interpretation
of **service as a commitment**

Agent B:
intended interpretation of
service as an action

Interpretations admitted by a
more precise A’s ontology

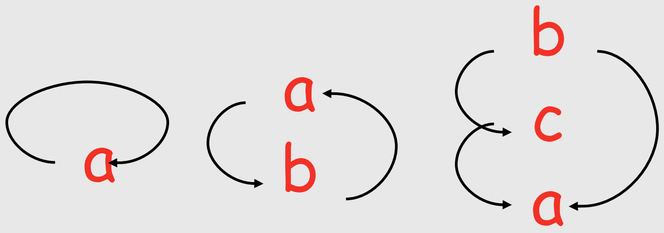
Interpretations admitted by a
more precise B’s ontology

When precision is not enough

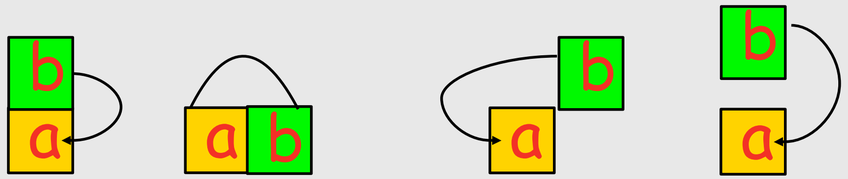
- Only one binary predicate in the language: *on*
- Only three blocks in the domain: *a, b, c*.
- Axioms:

$$on(x,y) \rightarrow \neg on(y,x)$$
$$on(x,y) \rightarrow \neg \exists z\, (on(x,z) \wedge on(z,y))$$

- This ontology is ***precise***, since non-intended ***models*** are excluded, but it is not ***accurate*** since it can't distinguish between real world ***examples*** and ***counter-examples***.



Excluded *models*



Indistinguishable *examples* and *counter-examples*

The reasons for ontology inaccuracy

- For a given conceptualization, the intended models of an ontology depend on the choice of vocabulary and domain of discourse.
- If these choices are poor (with respect to the conceptualization), a single intended ***model*** may not discriminate between positive and negative ***examples*** because of a ***mismatch*** between*:*
  - Cognitive domain and domain of discourse: lack of ***entities***
  - Conceptual relations and ontology relations: lack of ***primitives***

- Capturing all intended models is not sufficient for a “perfect” ontology

  Precision: non-intended *models* are excluded

  Accuracy: *counter-examples* are excluded

Are precision and accuracy really necessary? the case of *lightweight ontologies*

- Lightweight ontologies and core vocabularies (such as *schema.org*, the *W3C organization ontology*, or the *Core Public Service Vocabulary*) are deliberately underspecified, to favour ***reuse***.
- Reuse clearly reduces development costs, but does not necessarily increase interoperability, unless the meaning of terms is ***already* agreed upon**.
- If there is no previous agreement, lightweight ontologies cannot help achieving agreement, since they are (deliberately) unprecise and inaccurate.
- As a consequence, underspecification results in more reuse, but ***less interoperability*** *(people may use the same term in an* **inappropriate situation***)*

Interoperability is not compatible with underspecification!

Bibliography

- Carnap, Rudolf. 1952. Meaning Postulates. *Philosophical Studies* 3(5): 65–73.
- Guarino, Nicola. Formal ontology in information systems. In *Formal Ontology in Information Systems,* N. Guarino (Ed.), IOS Press, Amsterdam, 1998:3-15.
- Guarino, Nicola. Towards a formal evaluation of ontology quality. *IEEE intelligent Systems* 4(19), 2004:78-79.
- Guarino, N., Oberle, D., and Staab, S. 2009. What is an Ontology? In S. Staab and R. Studer (eds.), *Handbook on Ontologies*, Second Edition. International handbooks on information systems. Springer Verlag: 1-17