Laboratory for Applied Ontology

Institute of Cognitive Science and Technology
Italian National Research Council

Ontological Analysis

2 - What are ontologies

Nicola Guarino
Laboratorio di Ontologia Applicata (LOA)
Istituto di Scienze e Tecnologie della Cognizione (ISTC-CNR)
Trento, Italy

www.loa-cnr.it

What is an ontology

Ontology, lexicon, semantics

- Distinctions among contents: ***Ontology*** (capital ‘o’)
- Reference to content: ***Lexicon,*** via ***Semantics***

- Every organization, every computer system
  - Makes (implicit) ontologic assumptions
  - Adopt a certain lexicon, to which an ***intended semantics*** is ascribed.

Ontology and Ontologies

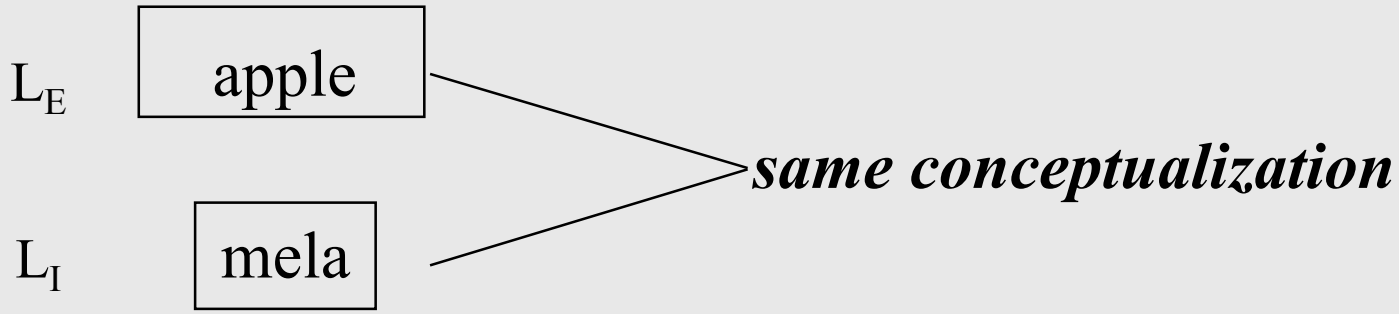
- ***Ontology***: the philosophical discipline
  - Study of ***what there is***
    (content *qua* content, even independently of its existence...)
  - Study of the ***nature*** and ***structure*** of "reality"
- ***ontologies***:

Specific (theoretical or computational) artifacts
expressing the ***intended meaning*** of a ***vocabulary***
in terms of ***primitive*** categories and relations describing
the ***nature*** and ***structure*** of a ***domain of discourse***

Gruber: "Explicit and formal specifications of a ***conceptualization***"

What is a conceptualization

- Formal structure of (a piece of) reality *as perceived and organized by an agent*, *independently* of:
  - the ***vocabulary*** used
  - the actual occurence of a specific ***situation***
- Different situations involving same objects, described by different vocabularies, may share the same conceptualization.



Relations vs. Conceptual Relations

ordinary relations are defined on a ***domain*** D:

$$r_n \in 2^{D^n}$$

conceptual relations are defined on a ***domain space*** <D, W>

$$\rho_n : W \rightarrow 2^{D^n}$$ *(Montague's intensional logic)*

A ***conceptualization*** for D is a tuple **C** = <D, W, $\Re$>,
where $\Re$ is a set of conceptual relations on <D, W>

A ***model*** for a language **L** with vocabulary V is a structure

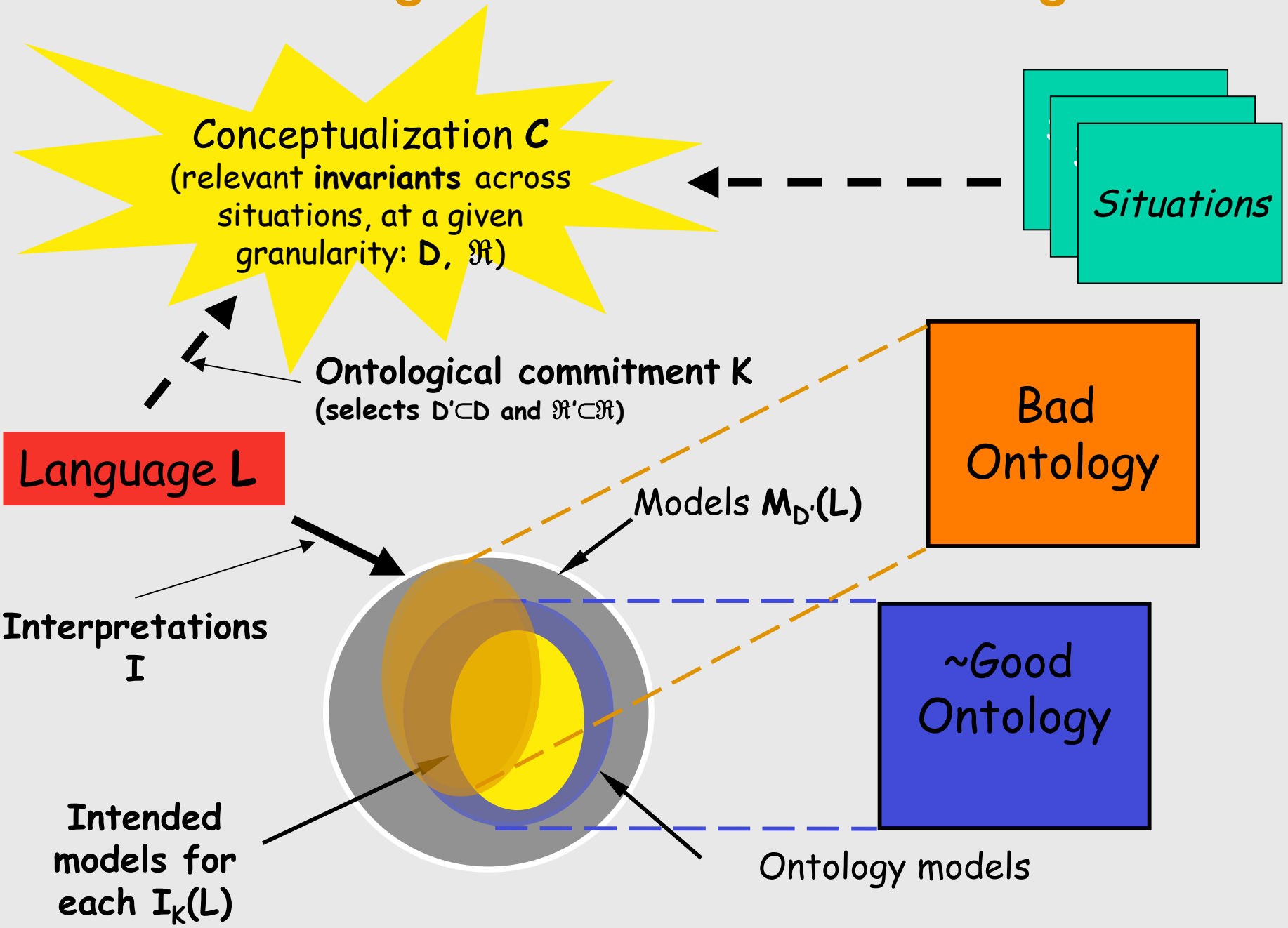
<**S**, I>, where **S** = <D, **R**> is a ***world structure*** and
I: V→D∪**R** is the usual interpretation function.

A model fixes a particular extensional interpretation of the language. Analogously, we can fix an ***intensional*** interpretation by means of a structure

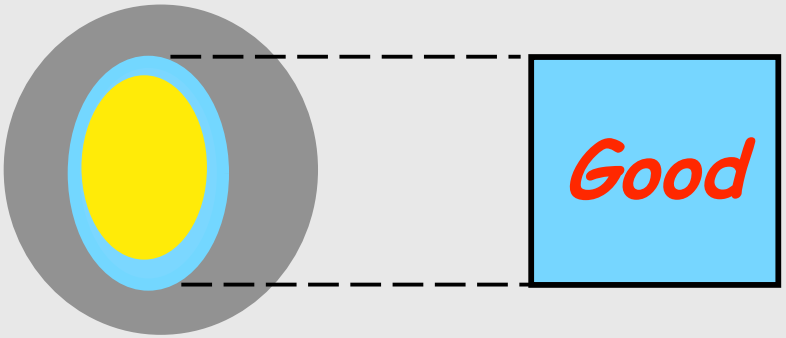
<**C**, $\Im$>, where **C** = <D, W, $\Re$> is a conceptualization and
$\Im$: V →D∪$\Re$ is an *intensional interpretation function*.

We call such a structure **K**=<**C**, $\Im$> an ***ontological commitment*** for **L**.
L ***commits*** to **C** by means of **K**.
C is the ***underlying conceptualization*** of **K**.

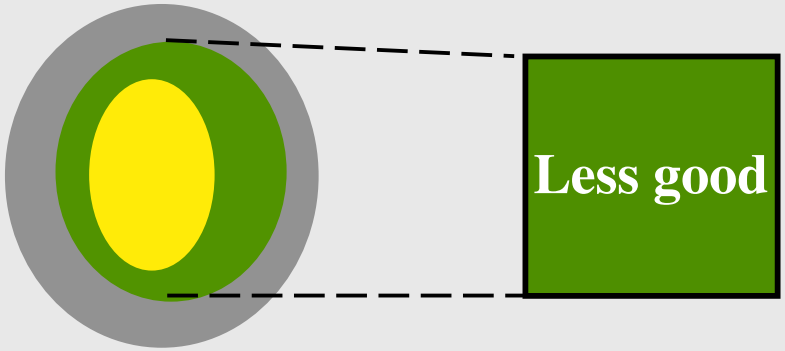
Ontologies and intended meaning



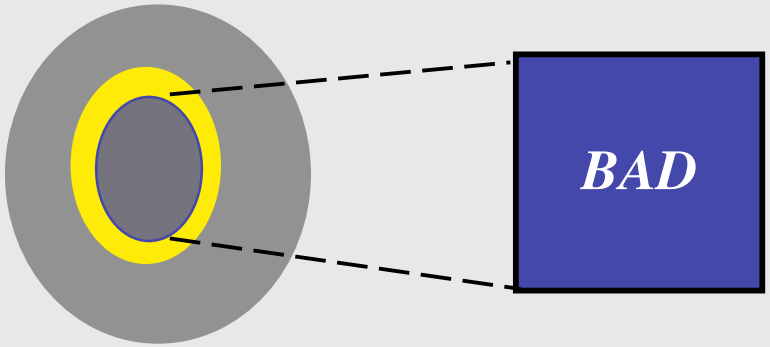
Ontology Quality: Precision and Coverage



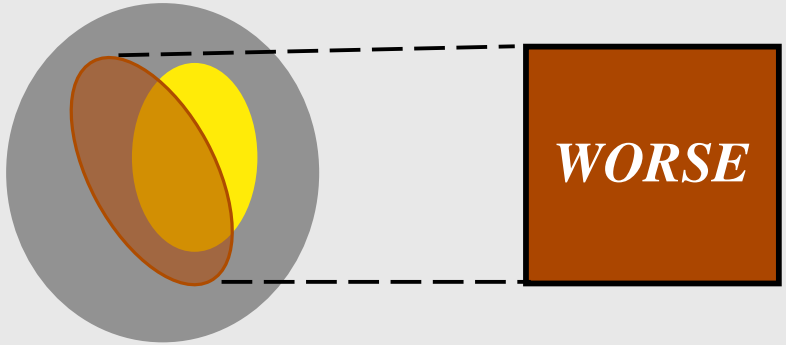
High precision, max coverage



Low precision, max coverage



Max precision, limited coverage



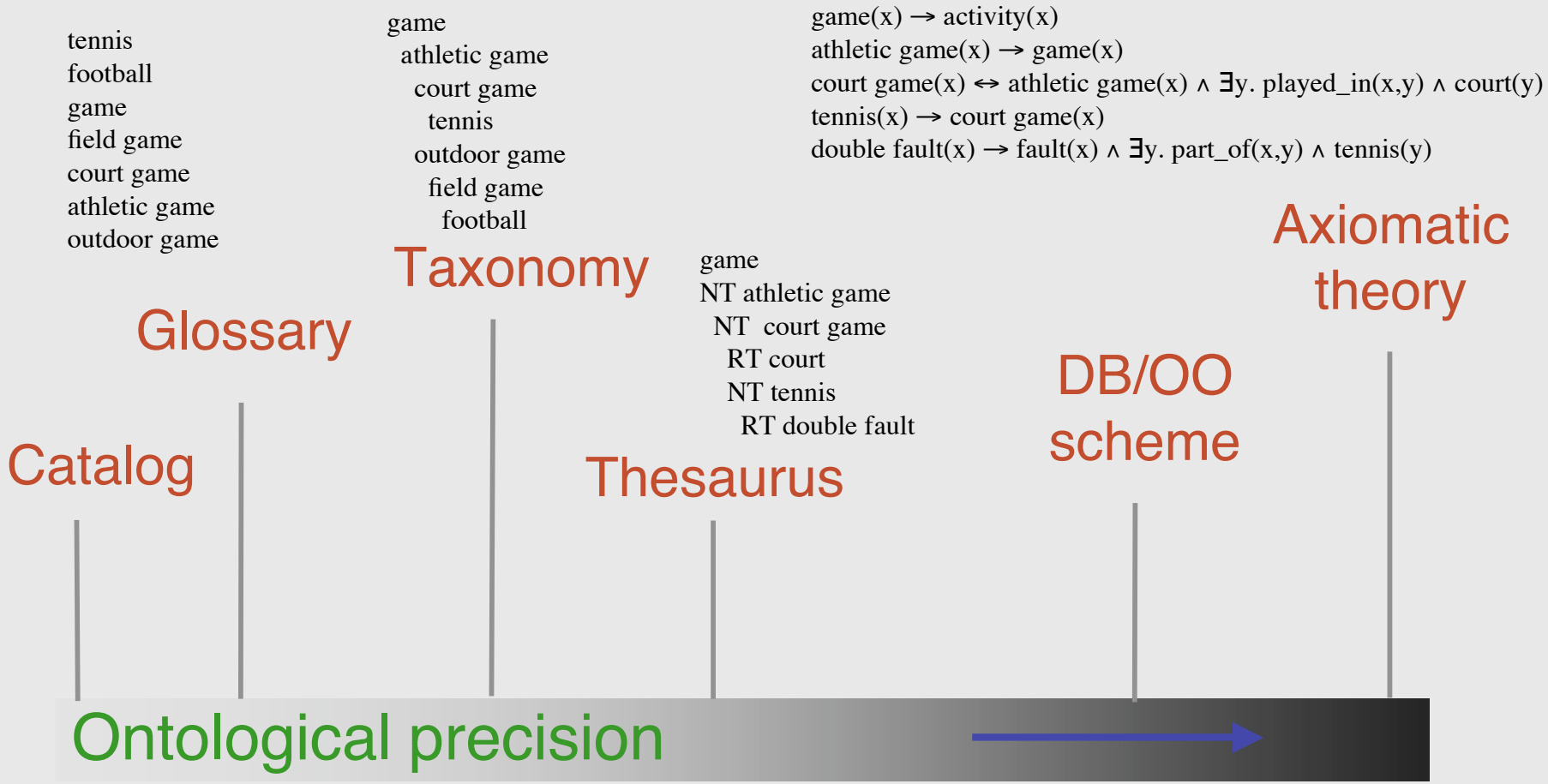
Low precision, limited coverage

A quantitative metric for ontology coverage and precision

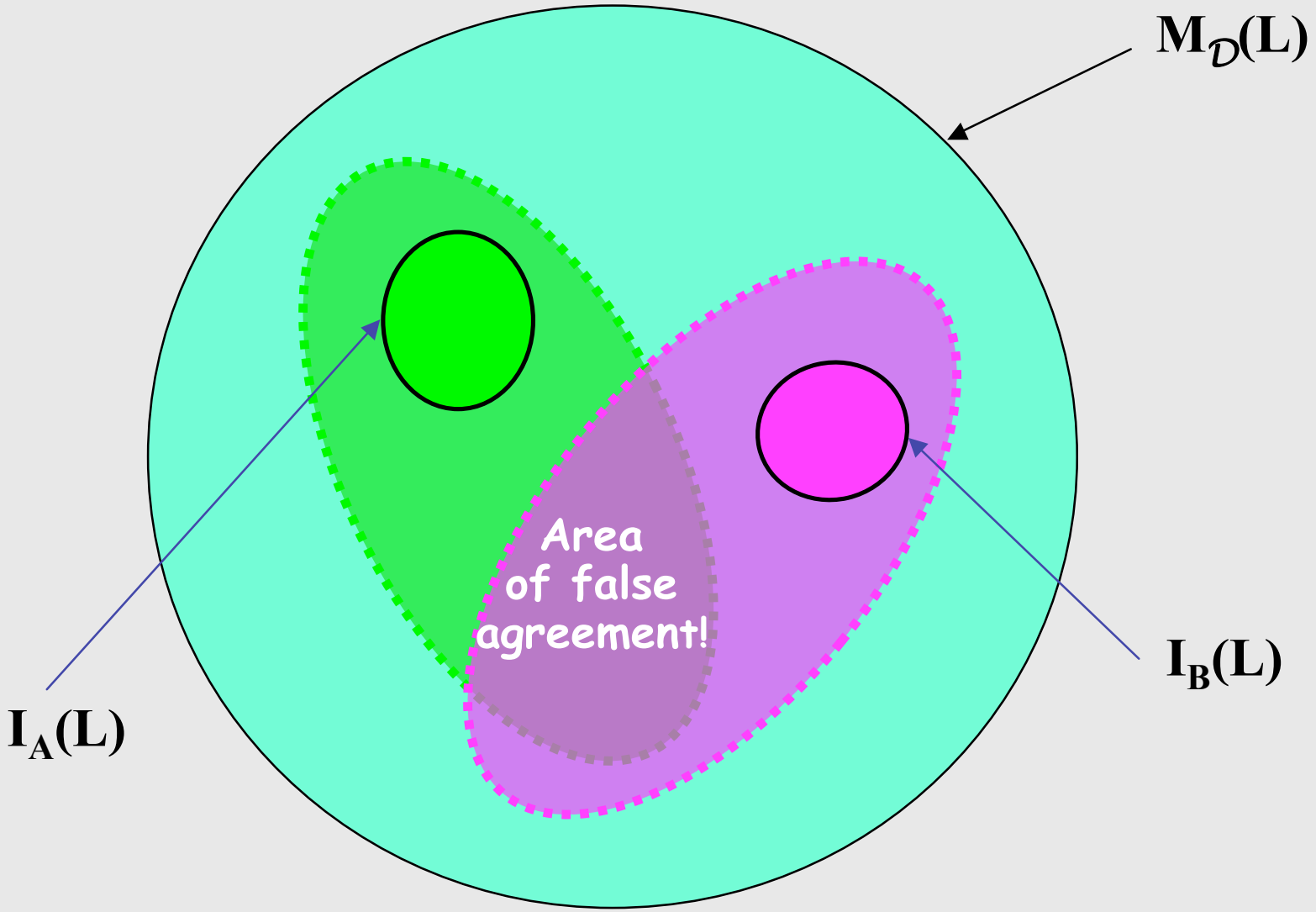
- Assumption: finite **D**, finite **W** *(examples)*

- Coverage = $card(I_k \cap O_k)/card(I_k)$
- Precision = $card(I_k \cap O_k)/card(O_k)$

Levels of Ontological Precision



Why precision is important



When precision is not enough

Only one binary predicate in the language: on

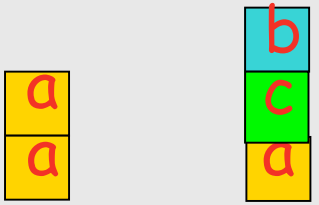
Only blocks in the domain: a, b, c, …

Axioms (for all x,y,z):

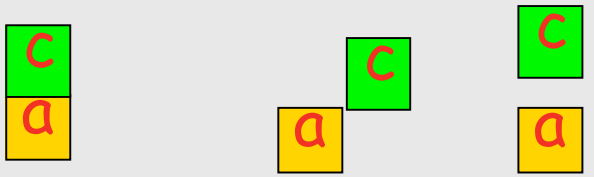
$on(x,y) \rightarrow \neg on(y,x)$

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

Non-intended *models* are excluded, but the rules for the competent usage of on in different *situations* are not captured.



Excluded situations



Indistinguishable situations

Precision vs. Accuracy

- In general, a single intended *model* may not discriminate among relevant alternative *situations because of*
  - Lack of *primitives*
  - Lack of *entities*
- Capturing all intended models is not sufficient for a “perfect” ontology

  Precision: non-intended *models* are excluded

  Accuracy: non-intended *situations* are excluded

Measuring ontological accuracy
(wrt benchmark examples)

- *Anomalous intended models* (set A_k): those that collapse intended and non-intended situations

$$\text{Accuracy} = (\text{card}(I_k)-\text{card}(A_k))/\text{card}(I_k)$$