Laboratory for Applied Ontology

Institute of Cognitive Science and Technology
Italian National Research Council

Formal Ontology and Knowledge Representation

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Course summary

1. Focusing on content; concepts and signs
2. What is an ontology
3. The ontological level
4. Ontology-driven information systems
5. The basic tools of formal ontology: essence, identity, unity, dependence, and constitution
6. The OntoClean methodology
7. Modelling roles
8. The ontology of material objects: parts and locations
9. Basic categories of the DOLCE ontology: objects, events, and qualities
10. Ontology of social reality: services and organizations

Bibliography

- Reference paper for the 1st part of the course:

  The Ontological Level: Revisiting 30 Years of Knowledge Representation.
  Guarino, N. In Alex Borgida, Vinay Chaudhri, Paolo Giorgini, Eric Yu (eds.), *Conceptual Modelling: Foundations and Applications*, Springer Verlag 2009: 52-67.

1. Focusing on content

The focus of ontological analysis: from form to *CONTENT*

- The key problems
  - content-based information access *(**semantic matching**)*
  - content-based information integration *(**semantic integration**)*

- To approach them, content must be studied, understood, analyzed ***as such***, independently of the way it is represented.

- Traditionally, computer technologies are not really good for that...

ontological analysis: study of
content *qua* content
(independently of *representation*)

Reality, conceptualizations, and models

- Reality
- Conceptualizations of reality
  - (represented by natural impressions)

- Conceptual models: *general* models of conceptualizations
  - (represented by *artificial* impressions)

- *Specific* models: specific situations satisfying general models
  - database snapshots
  - relational structures
  - *logical models*

The emergence of ontology in AI
(a very short story)

- The old days:
  - Semantic networks based on conceptual primitives
  - A progressive ***ontological neutralization*** of AI languages:
    - from conceptual primitives to *epistemological primitives*
    - the move towards ontologically neutral formalisms (DLs)
  - The short ***commonsense summer***
- The New Wave:
  - 80's: knowledge ***sharing*** and reuse
  - 90's: enterprise ***integration***
  - 2000: ***semantic*** web

The same problems are still there!

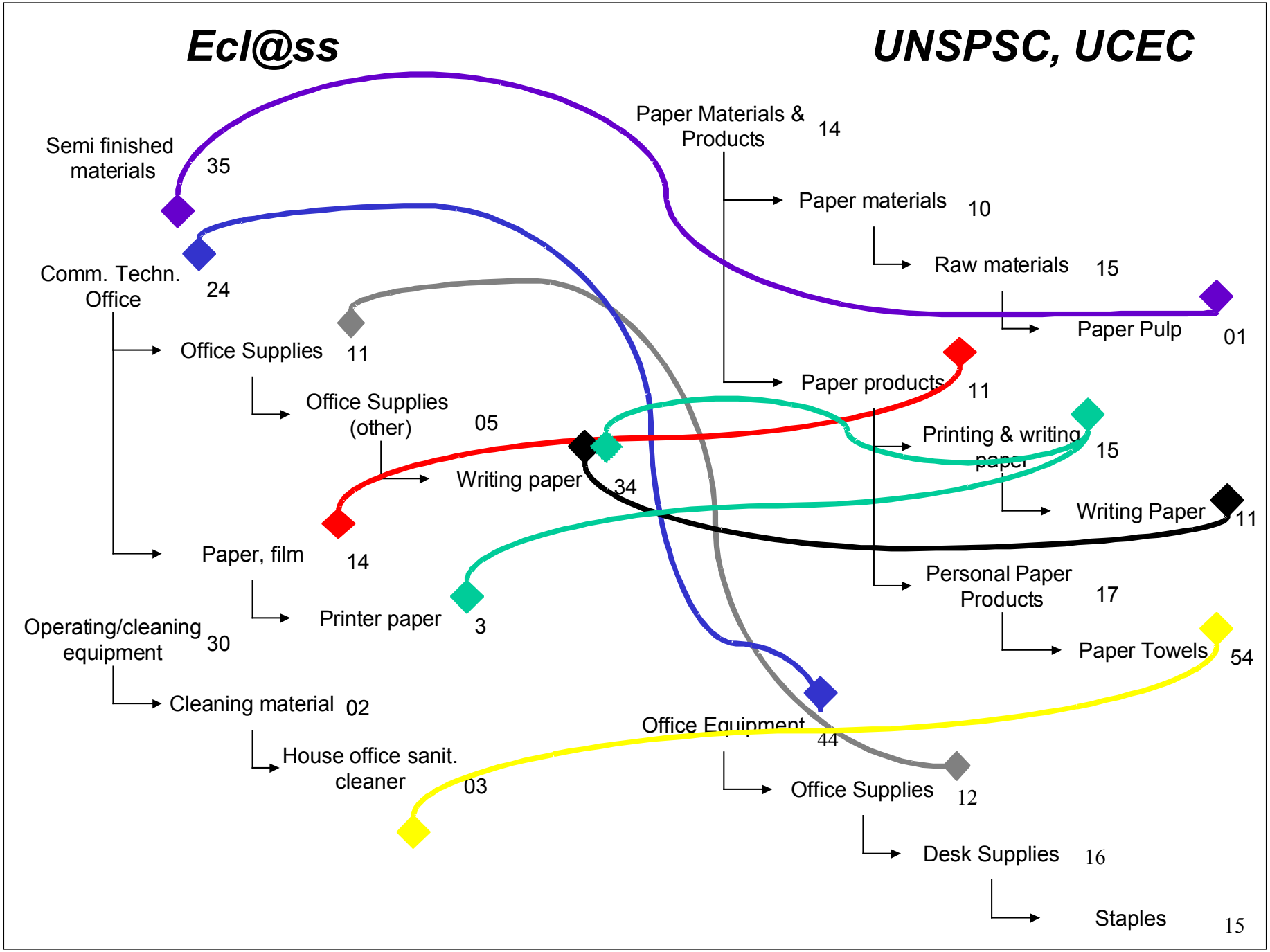
The problem: subtle distinctions in meaning

The e-commerce case:

"Trying to engage with too many partners too fast is one of the main reasons that ***so many online market makers have foundered***.

The transactions they had viewed as simple and routine actually involved many ***subtle distinctions in terminology and meaning***"

Harvard Business Review, October 2001


Ecl@ss
UNSPSC, UCEC
Semi finished materials 35
Comm. Techn. Office 24
Office Supplies 11
Office Supplies (other) 05
Writing paper 34
Paper, film 14
Printer paper 3
Operating/cleaning equipment 30
Cleaning material 02
House office sanit. cleaner 03
Paper Materials & Products 14
Paper materials 10
Raw materials 15
Paper Pulp 01
Paper products 11
Printing & writing paper 15
Writing Paper 11
Personal Paper Products 17
Paper Towels 54
Office Equipment 44
Office Supplies 12
Desk Supplies 16
Staples 15

Subtle distinctions in meaning...

- What is an ***application*** to a public administration?
- What is a ***service****?*
- What is a ***working place***?
- What is an ***unemployed person***?
- What is a ***customer****?*
- What is a ***passenger****?*
- What is an ***organization****?*
- What is a ***document****?*
- What is a ***contract****?*
- What is a ***spare part****?*

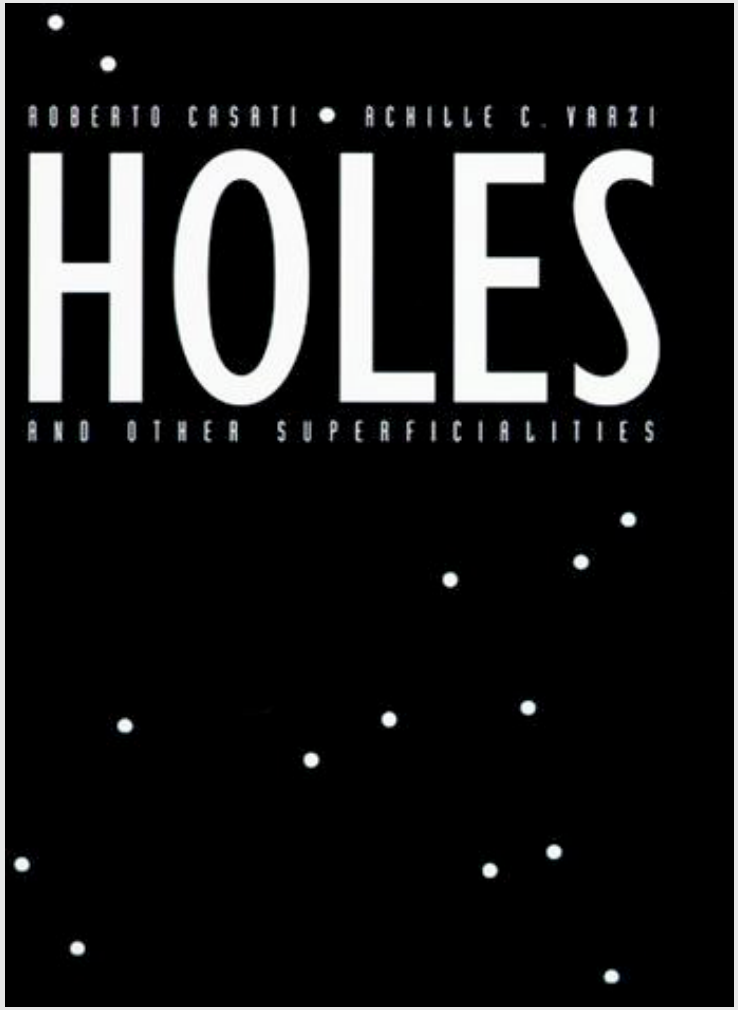
- What is ***telephone traffic****?* *What is* ***corruption****?*

Where subtle distinctions are important

- 2000 US Presidential elections: is there a ***hole***?
- 2001 twin towers catastrophe: how many ***events***?

…only ***ontological analysis*** solves these problems!!

The ontology of holes



Books by Roberto Casati and Achille C. Varzi (MIT Press):

- Holes and other superficialities
- Parts and places

A common alphabet is not enough…

- "XML is only the first step to ensuring that computers can communicate freely. ***XML is an alphabet for computers*** and as everyone who travels in Europe knows, knowing the alphabet doesn't mean you can speak Italian or French"

Business Week, March 18, 2002

Standard glossaries can help, but...

- Defining standard vocabularies is ***difficult and time-consuming***
- Once defined, standards ***don't adapt well***
- Heterogeneous domains need a ***broad-coverage vocabulary***
- People don't implement standards correctly anyway
- Vocabulary definitions are often ***ambiguous or circular***

Representation vs. Reasoning

- Representation comes first!
- The very task of representation (i.e. ***modelling***) is left to the user
- AI researchers focus more on the ***nature of reasoning*** than in the ***nature of the real world***

Essential ***ontological promiscuity*** of AI: any agent creates its own ontology based on its usefulness for the task at hand (Genesereth and Nilsson 1987)

...just talking of whatever we like?

Do we know what to REpresent?

- ***First*** ontological analysis,
- ***THEN*** knowledge representation…

Unfortunately, this is not the current practice…

No ontology without ***ontological analysis!***

The need to focus on content

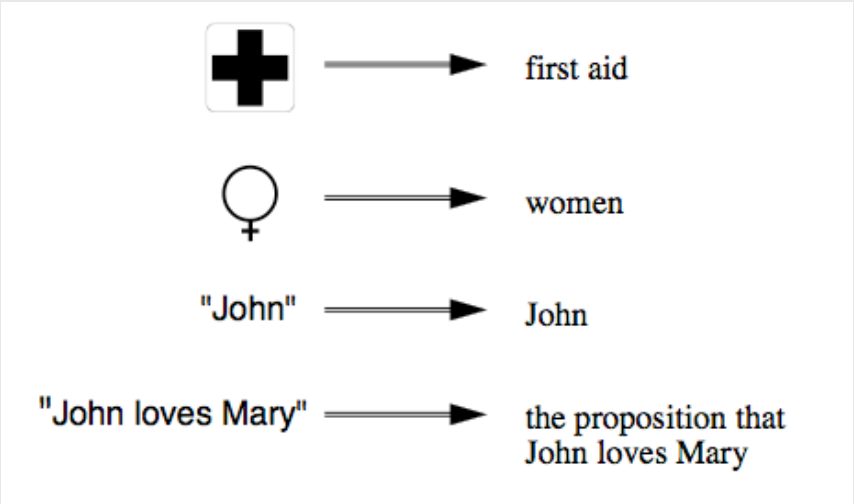
- Philosophers have generally stopped short of trying to actually specify the truth conditions of the basic atomic propositions, dealing mainly with the specification of the meaning of complex expressions in terms of the meanings of elementary ones. ***Researchers in artificial intelligence are faced with the need to specify the semantics of elementary propositions*** as well as complex ones. [Woods 1975]

- The majority of work in knowledge representation has been concerned with the technicalities of relating predicate calculus to other formalisms [...]. There has been almost an aversion to addressing the problems that arise in actually representing large bodies of knowledge with content. The typical AI researcher seems to consider that task to be 'just applications work'. But there are deep, important issues that must be addressed […]: What ontological categories would make up an adequate set for carving up the universe? How are they related? What are the important things most humans today know about solid objects? And so on. In short, we must ***bite the bullet***. [Doug Lenat]

2. Meanings and signs

Signs and their content

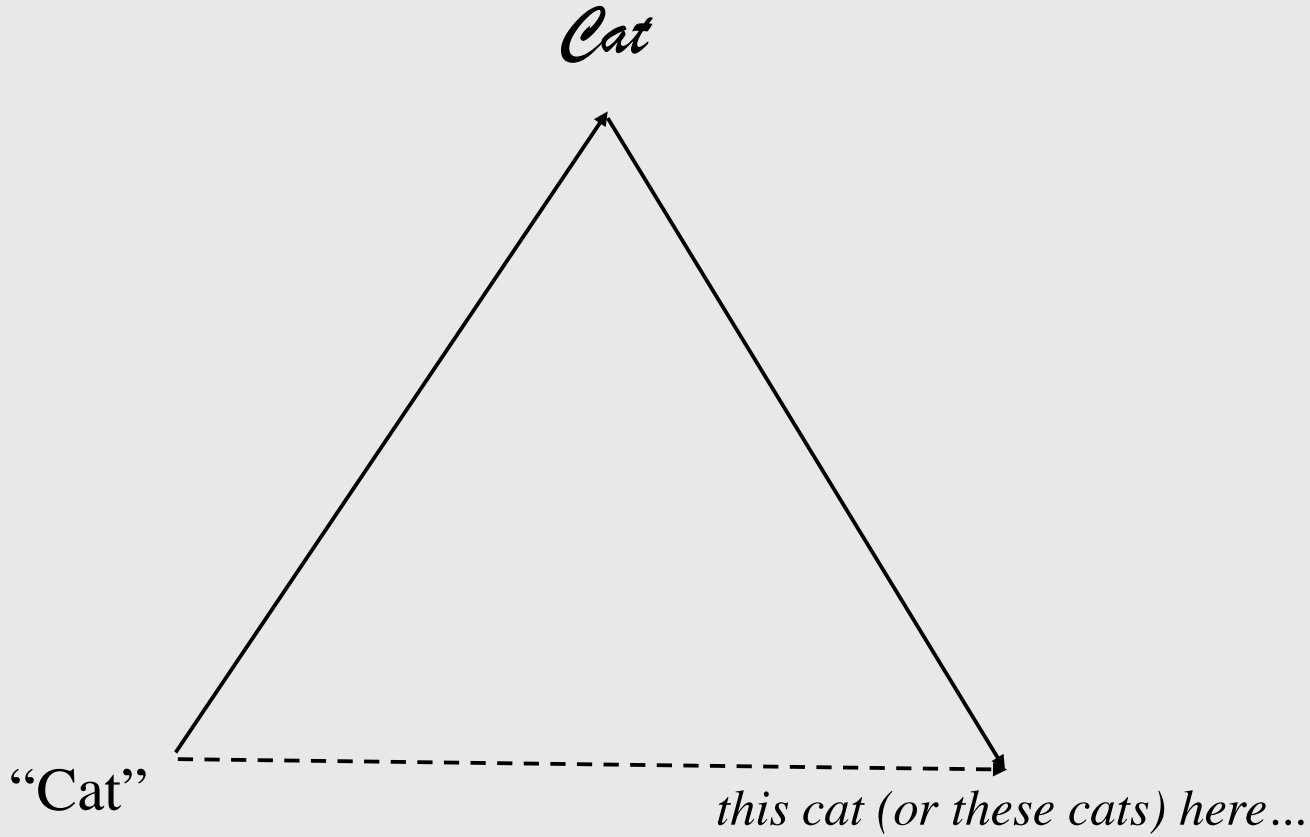
- Sign kinds in Peirce:
  - icon: **analogic** association with content
  - indexes: ***causal*** association
  - symbols: ***conventional*** assotiation



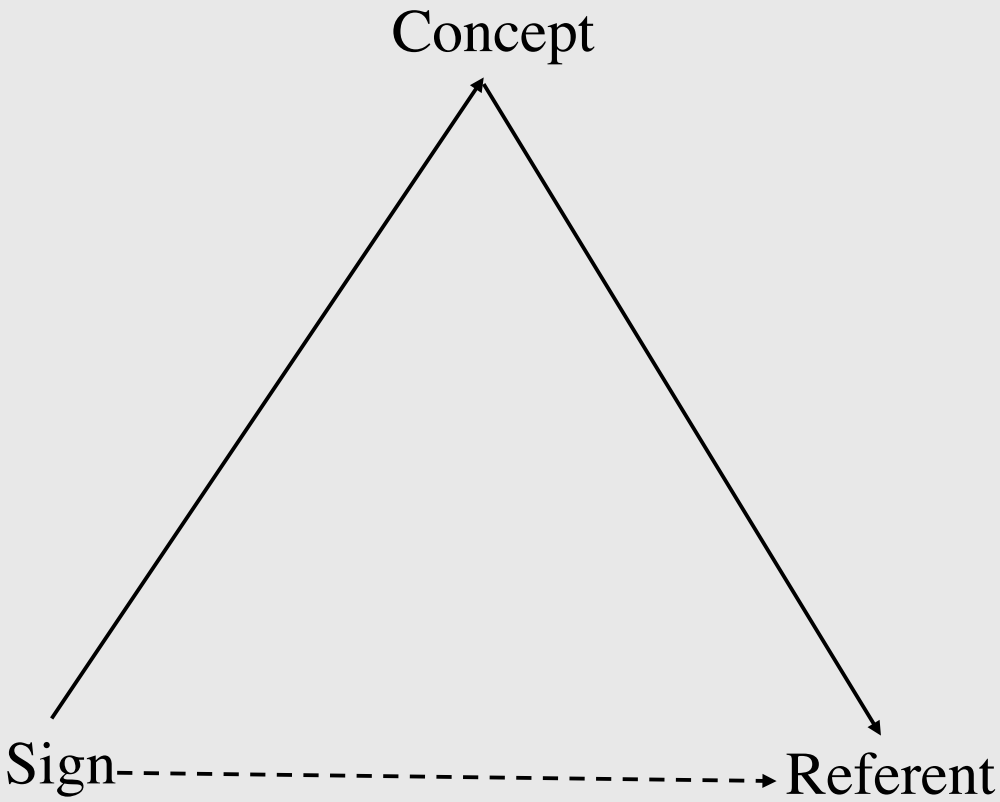
Signs and concepts

- Episodic memory vs. semantic memory:
  - we memorize both specific ***facts*** and general ***concepts***
- But what is a ***concept****?*
- What does it mean to represent it?

The triangle of meaning - 1



The triangle of meaning - 2



Intension ed extension

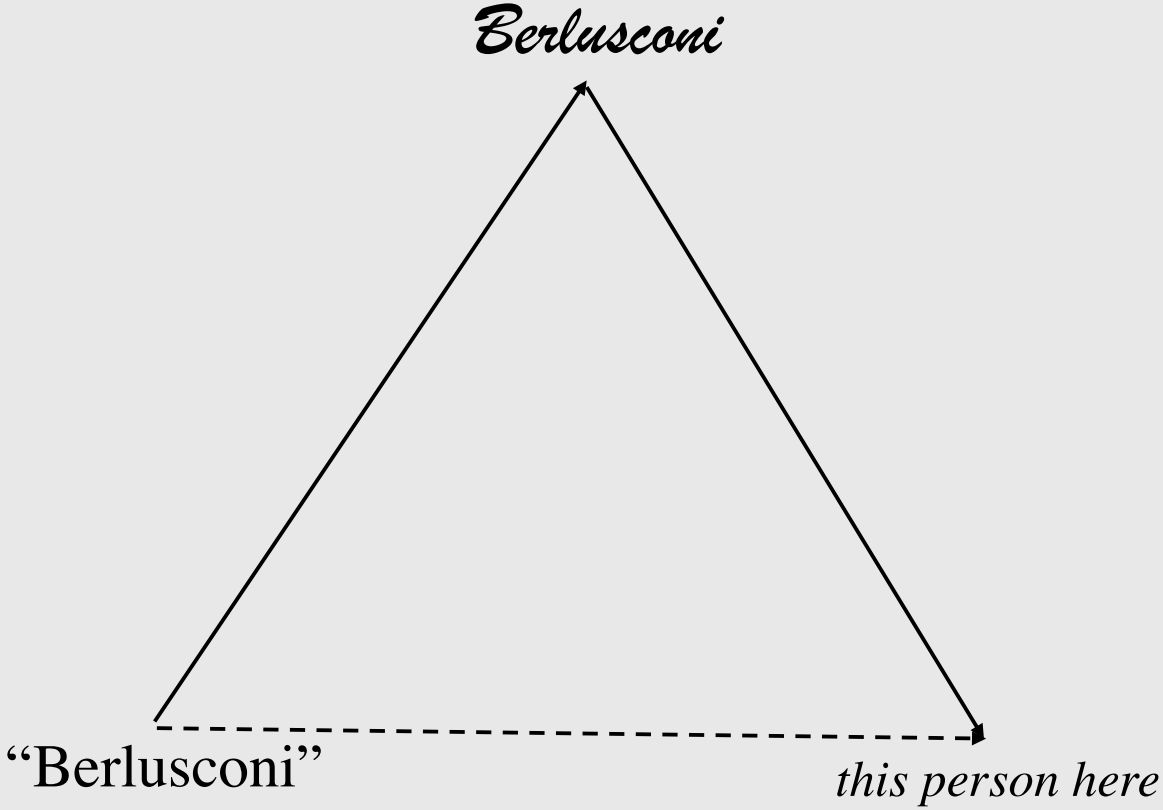
- Intension (concept): part of meaning corresponding to general principles, rules to be used to determine reference (typically, abstractions from experience)
- Extension (object): part of meaning corresponding to the effective reference
- Only by means of the ***concept*** associated to the ***sign*** “cat” we can correctly ***interpret*** this sign in various ***situations***
- The sign’s referent is the result of this interpretation
- Such interpretation is a ***situated intentional act***

Again on intension and extension

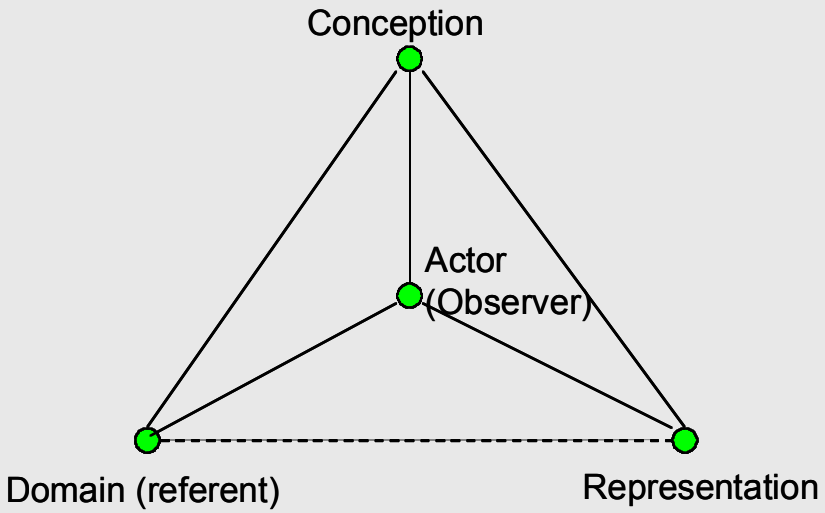
- Concepts with zero extension
  - square circle, unicorn (different cases!)

- Concepts with same extension and different intension
  - equilateral triangle and equiangular triangle
  - president of Council of Ministers and president of Milan (*definite descriptions)*
  - morning star and evening star

The triangle of meaning - 3



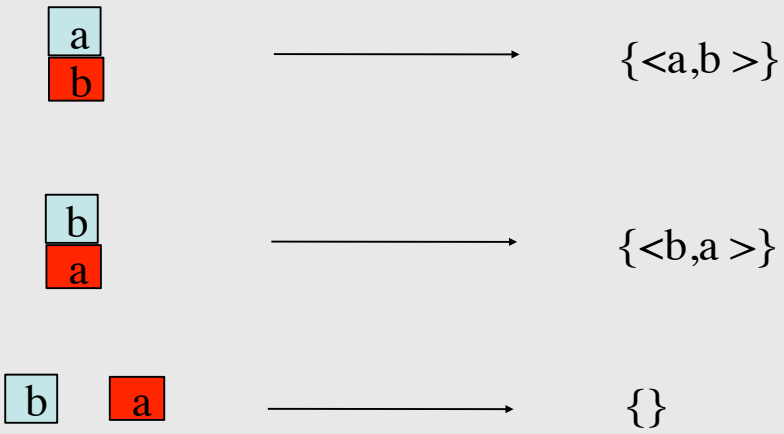
The FRISCO tethraedron



E. Falkenberg, W. Hesse, P. Lindgreen, B.E. Nilsson, J.L.H. Oei, C. Rolland, R.K. Stamper, F.J.M. Van Assche, A.A. Verrijn-Stuart, K. Voss: FRISCO - A Framework of Information System Concepts - The FRISCO Report. IFIP WG 8.1 Task Group FRISCO. Web version: http://www.mathematik.uni-marburg.de/~hesse/ papers/fri-full.pdf (1998)

Example 1: the concept of *red*

Example 2: the concept of *on*



Concepts, properties, and relations: terminology issues

- Non-relational concepts are often called ***properties***
- Relational concepts are often called ***relations***

- ...but properties and relations can be understood as intensional or extensional... Concepts are always **intensional**!!

- We also assume that properties are always intensional.

- To stress the difference between intensional and extensional relations, we shall call the former ***conceptual relations***
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