Laboratory for Applied Ontology

Institute of Cognitive Science and Technology
Italian National Research Council

5 - Identity

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Identity criteria

- *Classic formulation:*

$$\phi(x) \wedge \phi(y) \rightarrow (\rho(x,y) \leftrightarrow x = y)$$

(ϕ *carries the identity criterion* ρ)

- *Generalization:*

$$\phi(x,t) \wedge \phi(y,t') \rightarrow (\Gamma(x,y,t,t') \leftrightarrow x = y)$$

(synchronic: $t = t'$; diachronic: $t \neq t'$)

- In most cases, Γ is based on the ***sameness*** of certain ***characteristic features***:

$$\Gamma(x,y,t,t') = \forall z\,(\chi(x,z,t) \wedge \chi(y,z,t'))$$

- **Non-triviality condition:**
  - $\Gamma(x,y,t,t')$ must not contain an identity statement between x and y!

From identity *criteria* to weak identity *conditions*

- Finding necessary *and* sufficient ICs for a given property may be ***very hard***.
- In most cases, to apply the OntoClean methodology it is enough to detect whether a certain property *P* carries *supplementary membership conditions* (in addition to those logically implied by *P* itself)
- A property *P* carries an identity *condition C* if all its instances necessarily satisfy *C*, and *C* is not logically implied by *P*
- Typical example: ***having some essential parts or qualities***

Sortals and other properties

- **Sortals** (*horse, triangle, amount of matter, person, student...)*
  - Carry identity conditions
  - Usually correspond to ***nouns***
  - High organizational utility
- **Non-sortals** *(red, big, old, decomposable, dependent...)*
  - No identity
  - Usually correspond to ***adjectives***
  - Span across different sortals
  - Limited organizational utility (but high semantic value)

What about our rocks?

- *Igneous rock, metamorphic rock, sedimentary rock*
  do supply identity conditions.
- *Large rock, grey rock, pet rock*
  DO NOT!
- Not all properties are the same...

Carrying vs. Supplying Identity

- ***Supplying*** identity (**+O**)
  - Carrying an IC (or relevant essential property) that doesn't hold for *all* directly subsuming properties
- ***Carrying*** identity (**+I**)
  - Not supplying identity, while being subsumed by a property that does.
- ***Common sortal principle***: x=y -> there is a common sortal supplying their identity

- Theorem: only rigid properties supply identity

Identity, Countability, and Mass Nouns

- Nouns vs. adjectives
- Countability implies identity
- The problem with mass nouns: does the viceversa hold?
  - Being [an amount of] water:
    - Uncountable if arbitrarily divisible (but still carries identity!)
    - Countable if we assume molecules
      - We do have criteria for distinguishing and counting water molecules
      - We do have criteria for distinguishing and counting sums of water molecules
      - [compare with “being a group of people”]
  - Being made of water:
    - if x and y are made of water, nothing helps us to decide whether they are identical or not
  - So, “Being an amount of water” is a sortal,”Being made of water” is not.

Identity Disjointness Constraint

ICs impose ***constraints*** on sortals, making their ontological nature explicit:

> Properties with incompatible ICs are ***disjoint***

Examples:

- countries vs. geographical regions
- passengers vs. persons
- assemblies vs. amounts of matter
- sets vs. ordered sets

Unity as a special case of identity condition

Properties with incompatible unity conditions are ***disjoint***

Unity-related metaproperties for a property P:

- +U: all instances of P have a *common* unity criterion
- ~U: no instance of P has a unity criterion
- -U: some instances of P have a unity criterion

Why bother with this?

- ***Formal ontological analysis*** requires analyzing all properties according to their meta-properties – This is a ***lot*** of work!
- Why perform this analysis?
  - Makes ***modeling assumptions*** clear, which:
    - Helps resolving known conflicts
    - Helps recognizing unkown conflicts
  - Imposes ***constraints*** on standard modeling primitives (*generalization, aggregation, association*)
  - Elicits ***natural distinctions***
  - …results in more ***reusable ontologies***

Taxonomic constraints

- $+R \not\subset \sim R$
- $-I \not\subset +I$
- $-U \not\subset +U$
- $+U \not\subset \sim U$

- Incompatible IC's are disjoint
- Incompatible UC's are disjoint

Resolving Ontological Conflicts

- Two well-known linguistic ontologies define:
  - ***Physical Object is-a Amount of Matter*** (WordNet)
  - ***Amount of Matter is-a Physical Object*** (Pangloss)

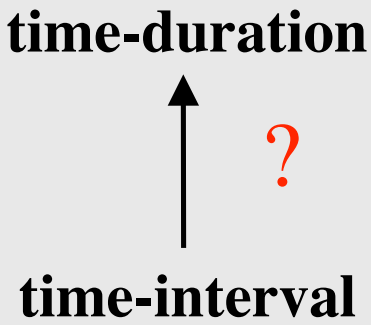
- Amount of Matter
  - unstructured /scattered “stuff”
  - Identity: mereologically extensional
  - Unity: intrinsically none (anti-unity)

- Physical Object
  - Isolated material body
  - Identity - three options:
    - None
    - Non-extensional
    - Extensional
  - Unity: Topological

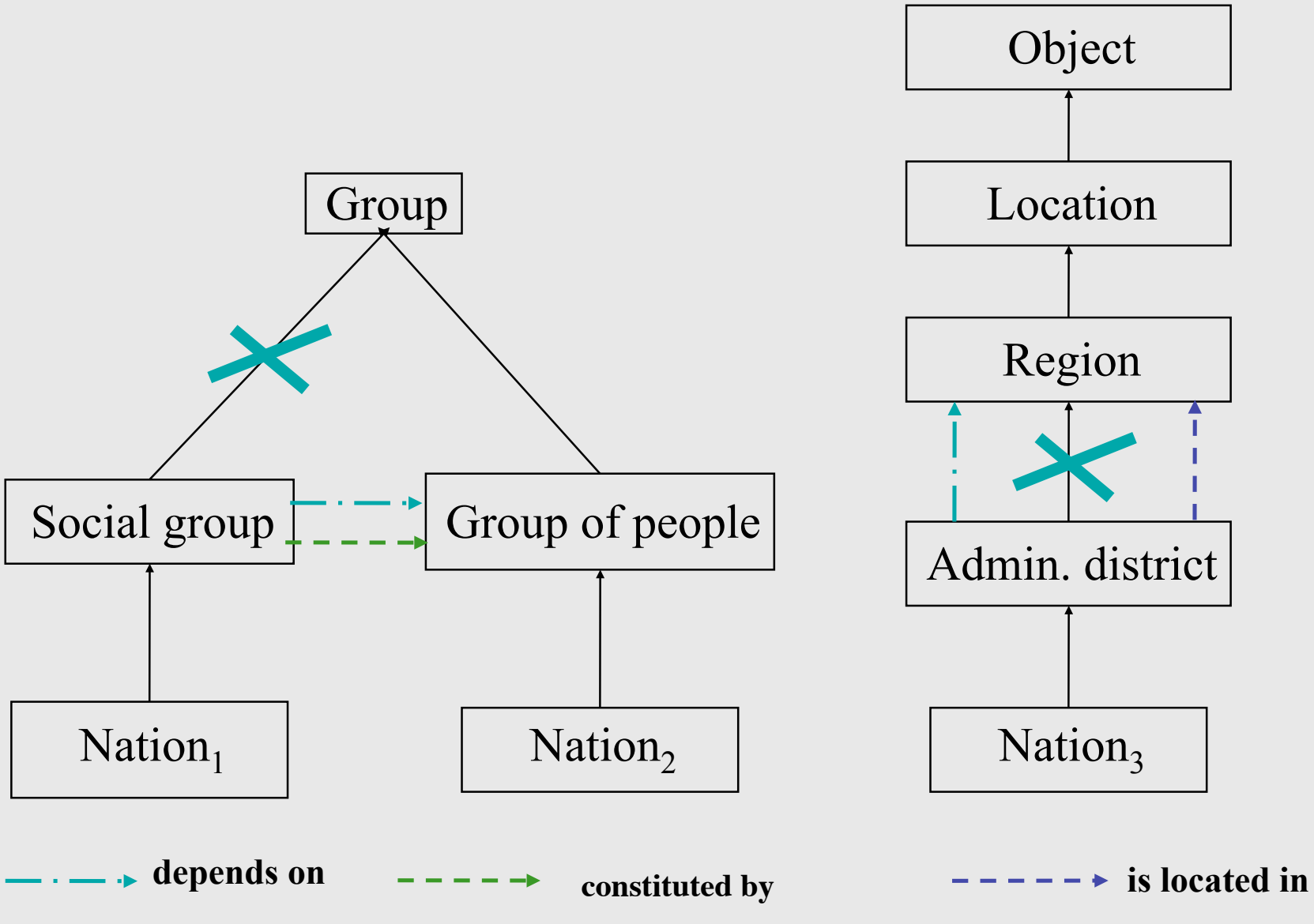
Conclusion: the two concepts are ***disjoint***. Physical objects are ***constituted*** by amounts of matter

Example - Identity

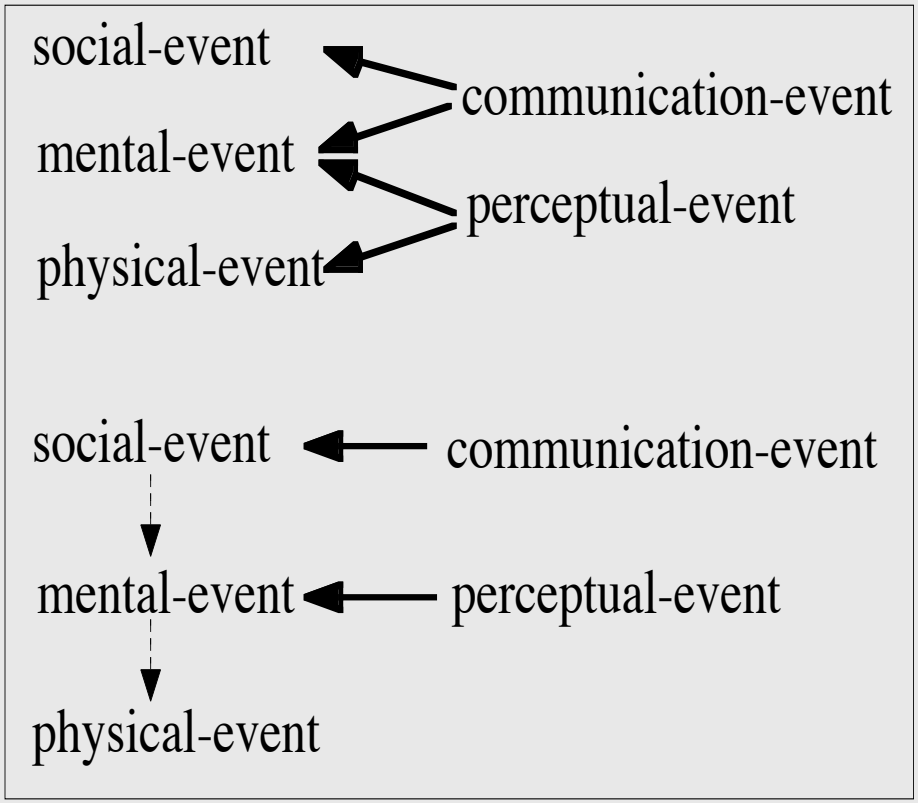
- Is *time-interval* a subclass of *time-duration*?
  - Initial answer: yes
- IC for *time-duration*
  - Same-length
- IC for *time-interval*
  - Same start & end



The case of “Nation”



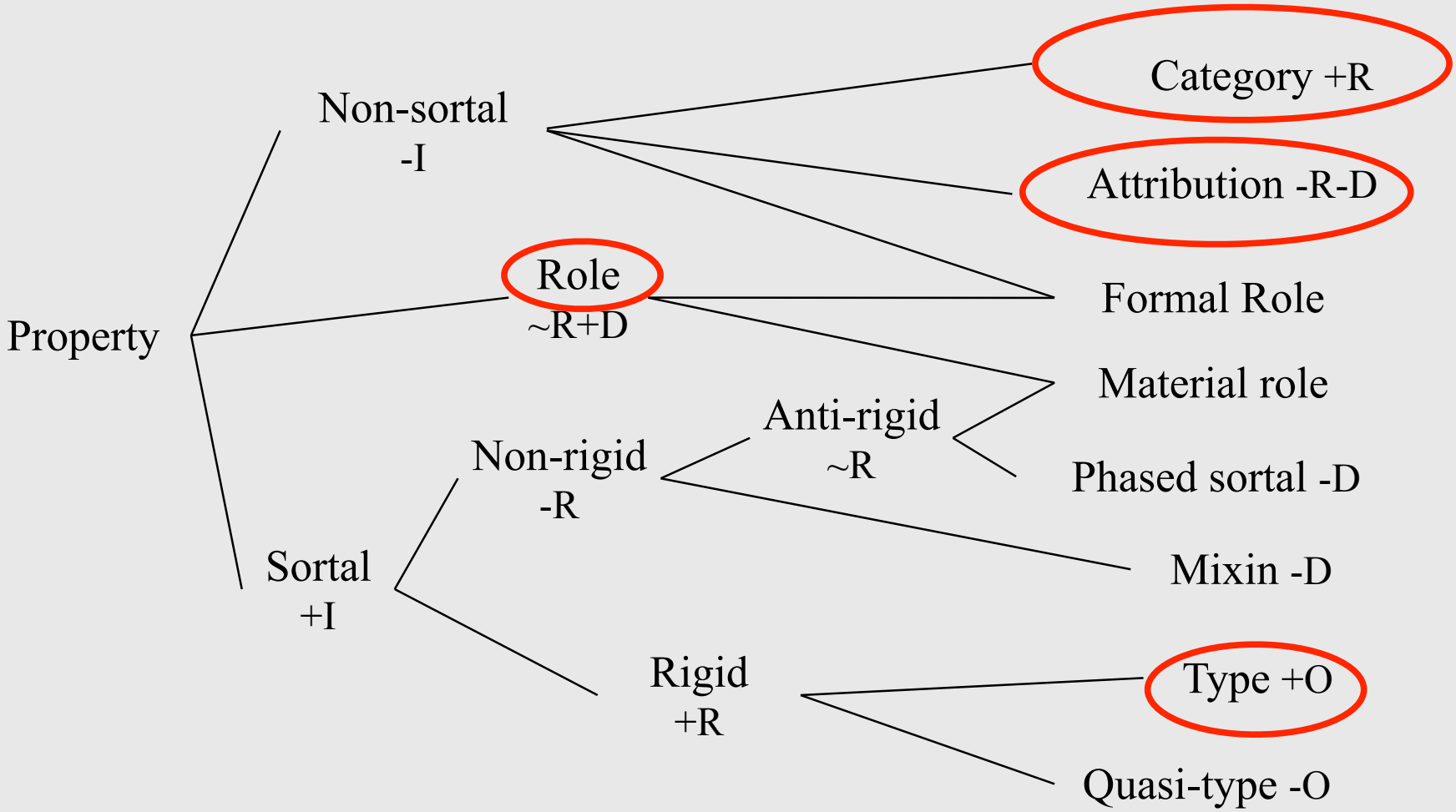
How ontological levels simplify taxonomies



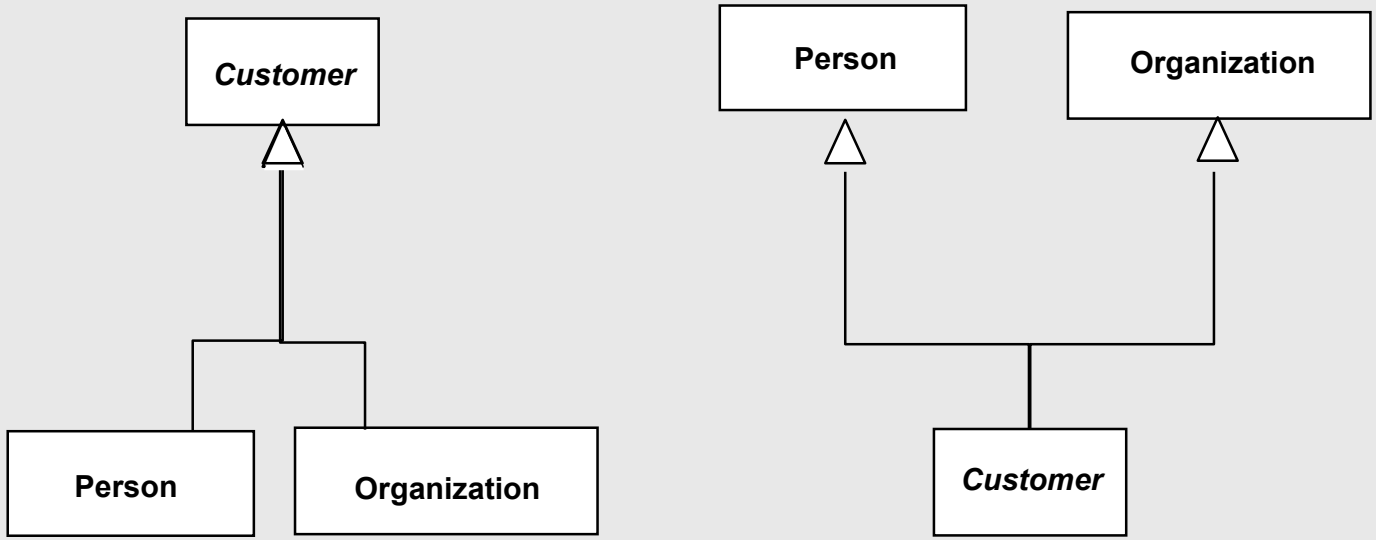
Dependence

- Between particulars
  - ***Existential dependence*** (specific/generic) *(*also *constant dependence)*
    - Hole/host, person/brain, person/heart
  - Internal vs. external dependence
    - Region/boundary....
  - Historical dependence
    - Person/parent
  - Causal dependence
    - Heat/fire
- Between universals
  - ***Definitional dependence***
    - *P* depends on *Q* iff *Q* is involved in the **definition** of *P [Fine 1995]*.
    - Metaproperties: +D/-D

A formal ontology of properties



What's the right model?



a b

The solution [Guizzardi 2005]