Unity and Plurality

- *Ordinary objects:* ***wholes or sums of wholes***
  - *Singular*: ***no wholes as proper parts***
  - *Plural*: ***sums of wholes***
    - *Plural wholes* (the sum is ***also a whole***)
    - *Collections* (the sum is not a whole)

Carrying essential properties

- A property P *carries* an ***informative*** essential property Q (different from P) iff Q is essential to all instances of P, **and yet Q is not rigid**:
  - Every person must have a brain.
- Compare with:
  - Every person must be a mammal.

Carrying an informative essential property implies carrying a (minimal) ***identity criterion***

What about our rocks?

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

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!

Heuristics for Identity

- Finding necessary *and* sufficient ICs for a given property may be ***very hard***.

- Heuristic 1: ***at least a sufficient IC***.
- Heuristic 2: ***some essential (non-rigid) properties***
  - ***(such as having some essential parts or qualities)***

Carrying vs. Supplying Identity

- ***Supplying*** (global) 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

Sortals and other properties

- **Sortals** (*horse, triangle, amount of matter, person, student...)*
  - Carry (non-trivial) 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)

Identity and Countability

- Nouns vs. adjectives
- Countability implies identity
- ...although countability is not necessary for identity:
  - Being made of water:
    - if x and y are made of water, nothing helps us to decide whether they are identical or not
  - Being [an amount of] water:
    - Compare with “group of people”
    - We do have criteria for distinguishing and counting water molecules
    - We do have criteria for distinguishing and counting sums of water molecules
- 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***

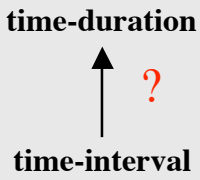
Examples:
- countries vs. geographical regions
- passengers vs. persons
- assemblies vs. amounts of matter
- sets vs. ordered sets

Why bother with this?

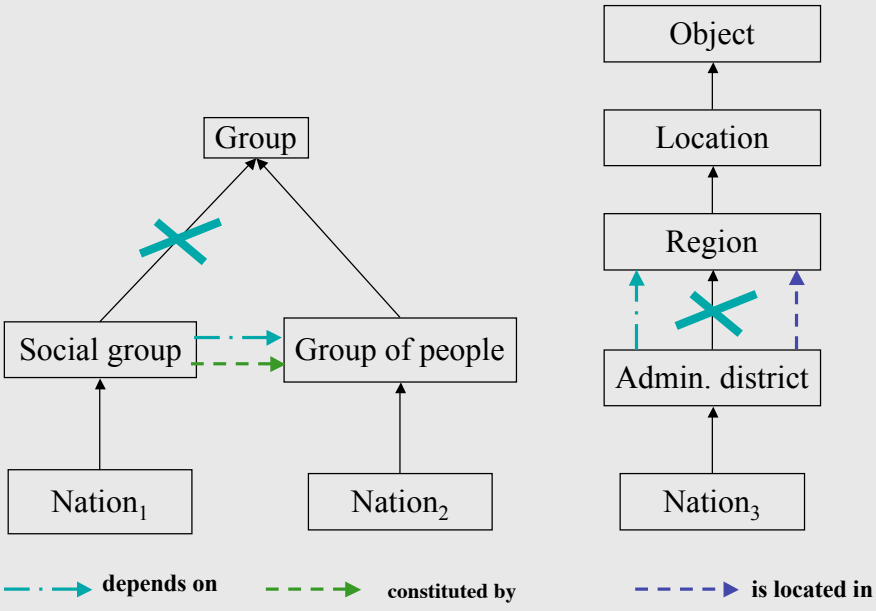
- ***Formal ontological analysis*** requires analyzing all properties according to their meta-properties – This is a ***lot*** of work!
- Why perform this analysis?
  - Makes ***modeling assumptions*** clear, which:
    - Helps resolving known conflicts
    - Helps recognizing unkown conflicts
  - Imposes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

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"



Taxonomic Constraints

- +R ⊄ ~R
- -I ⊄ +I
- -U ⊄ +U
- +U ⊄ ~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

IS-A overloading

- ***Reduction of sense:***
  1. A *physical object* is an *amount of matter* (Pangloss)
  2. An *association* is a *group* (WordNet)
- ***Overgeneralization:***
  3. An *amount of matter* is a *physical object* (WordNet)
  4. A *place* is a *physical object* (*μ*Kosmos, WordNet)
- ***Clash of senses:***
  5. A *window* is both an *artifact* and a *place* (*μ*Kosmos)
  6. A *person* is both a *physical object* and a *living thing* (Pangloss)
  7. A *communicative event* is a *physical*, a *mental*, and a *social event* (*μ*Kosmos, Pangloss)

How ontological levels simplify taxonomies