



# Ontological Analysis

## 6 - Types & Roles

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# Sortal specialization

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- **Type** specialization (e.g. Living being → Person)
  - New features (especially essential properties) **affect identity**
  - ICs are added while specializing types
    - Polygon: same edges, same angles
      - Triangle: two edges, one angle
    - Living being: same DNA, etc...?
      - Zebra: same stripes?
- **Role** specialization (e.g. Person → Student)
  - New features **don't affect identity**



# Roles are ‘dynamic’ and ‘antirigid’

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Basic Idea (Steimann 2000): Roles have temporal/modal relations with their players

- An entity can play different roles simultaneously
  - *In 2003, B. was the Italian Prime Minister, the President of the European Union, the president of the Forza Italia party, the owner of the Mediaset company, an Italian citizen, a defendant at a legal trial.*
- An entity can cease playing a role (*antirigidity*)
  - *In 1960, B. was a piano bar singer, now he is the IPM.*
- An entity can play the same role several times, simultaneously
  - *In 2003, B. had two presidencies / was president twice.*
- A role can be played by different entities, simultaneously or at different times
  - *Today, there are 4319 Italian National Research Council researchers.*
  - *In 2000, the Italian Prime Minister was D., now it is B.*

# Roles have a relational nature

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- Basic Idea (Sowa, Guarino&Welty)  
Roles imply patterns of relationships, i.e., they **depend**—via these patterns—on additional ‘external’ properties
- Which kind of dependence?
  - “Identificational” dependence (Sowa) and “notional” dependence (Guarino&Welty 2002) are not restrictive enough
    - A car is “identificationally” dependent on its wheels
    - Socrates is “notionally” dependent on the singleton {Socrates}
  - “Definitional” dependence (Fine 1995) avoids these problems:  
“to say that an object  $x$  depends upon an  $F$  is to say that an  $F$  will be ineliminably involved in any **definition** of  $x$ .”



# Dependence

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



# The dual nature of roles [Masolo et al 2004]

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- Basic Idea (Sowa 2000)  
Roles can be ‘predicated’ of different entities, i.e., different entities can play the same role
- Standard representation  
Roles as properties
- Social (and dynamic) aspects of roles not accounted for
  - Roles are created and disappear; are defined by conventions; are adopted and accepted by communities of agents
- Roles need to be considered **both** as properties and “first-class citizens”



# Roles are ‘properties’

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- Basic Idea (Sowa 2000)  
Roles can be ‘predicated’ of different entities, i.e., different entities can play the same role
- Standard representation  
Roles represented, in some FO language, as unary predicates whose instances are their players
- Social (and dynamic) aspects of roles not accounted for
  - Roles are created and disappear; are defined by conventions; are adopted and accepted by communities of agents
- Roles need to be considered **both** as properties and “first-class citizens”



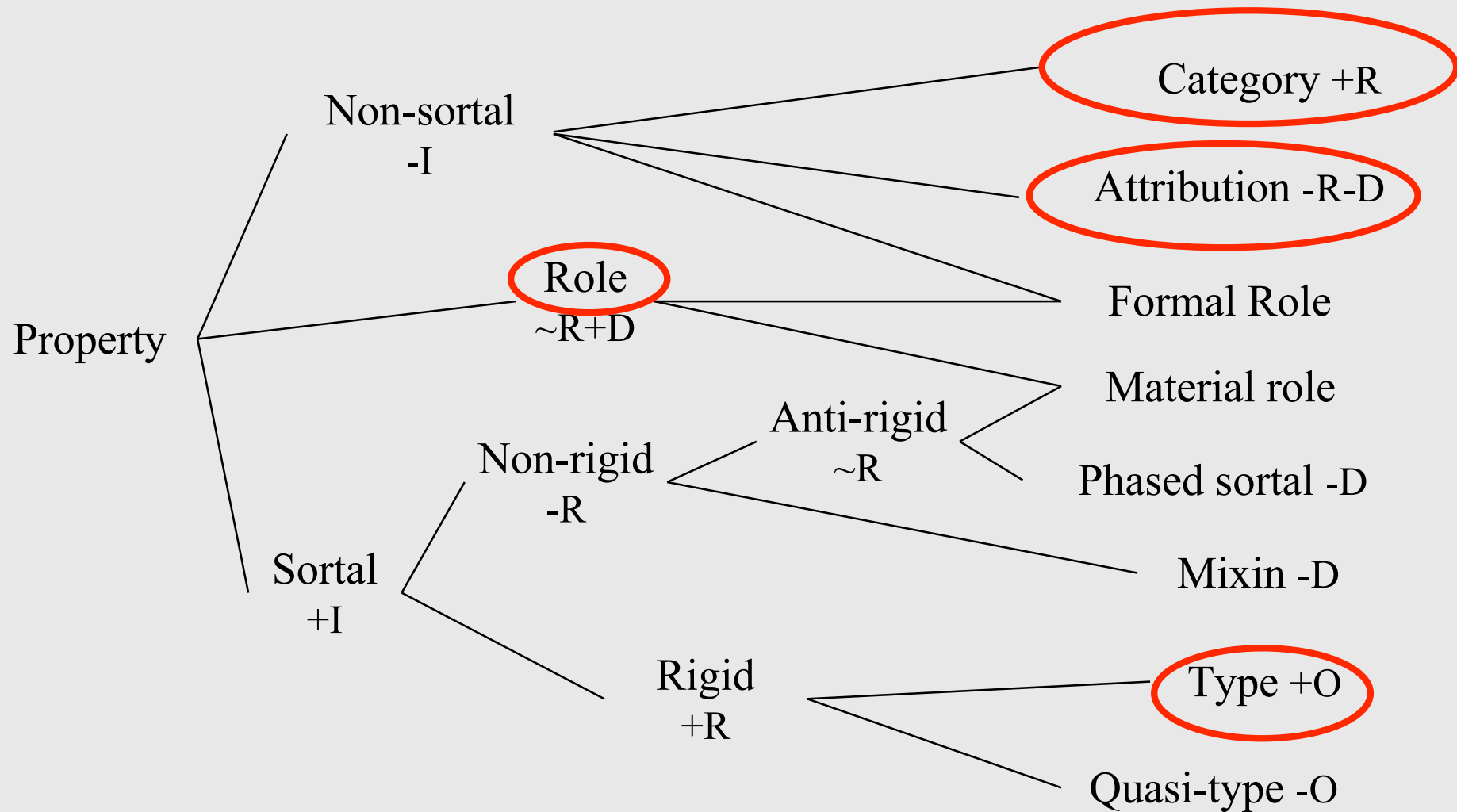
# Roles are determined by contexts

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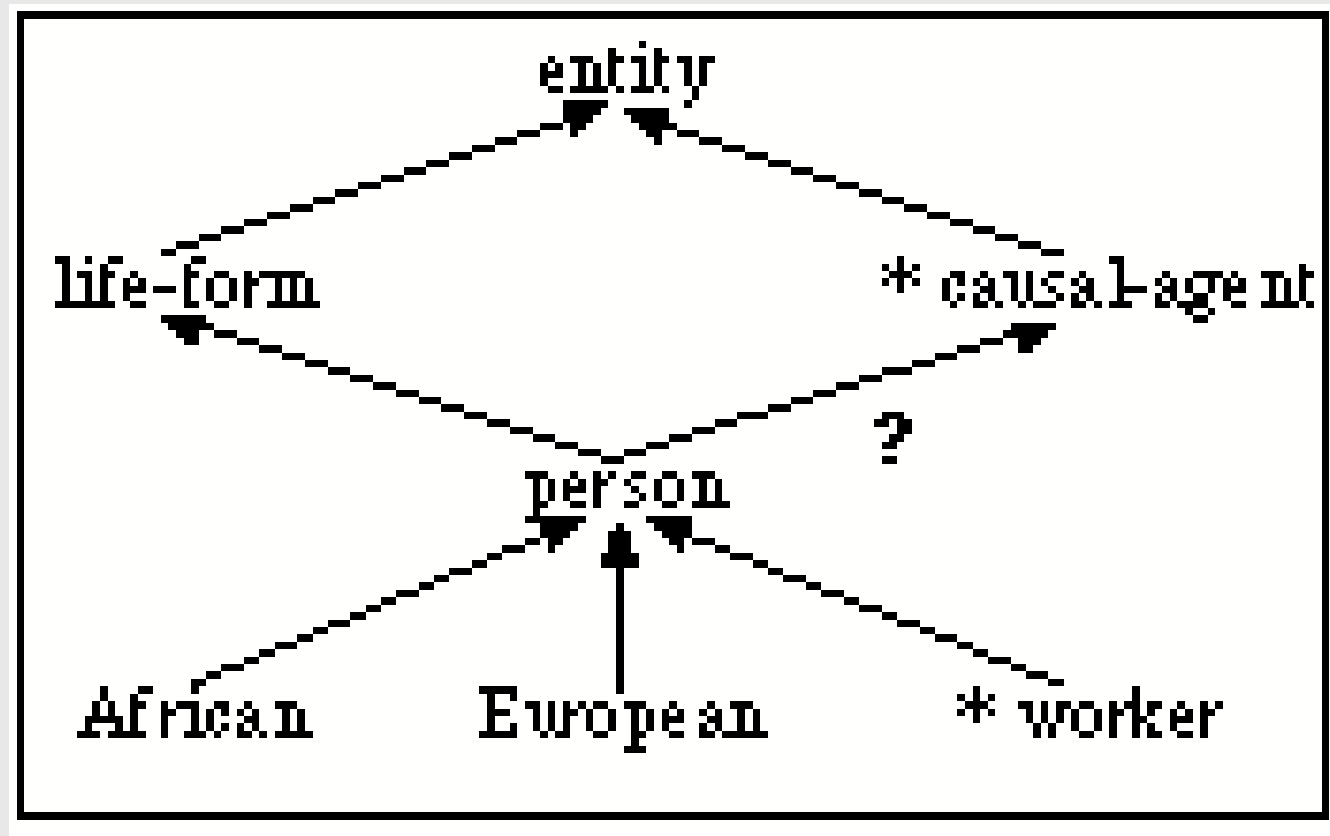
- Basic Idea  
Roles are characterized by some external entities (contexts, pattern of relationships, modalities of participation in an event, abstract descriptions of agents' behavior in organizations, etc.)
- Context, most general notion (Searle)
- Contexts as representations of the social conventions that "define" social concepts
  - *Cognitive context*: a theory that provides definitions of concepts, to be used as background for the interpretation of certain states of affairs (McCarthy, Giunchiglia&Ghidini)
  - Dependent on communities of agents



# A formal ontology of properties



# Types and Roles



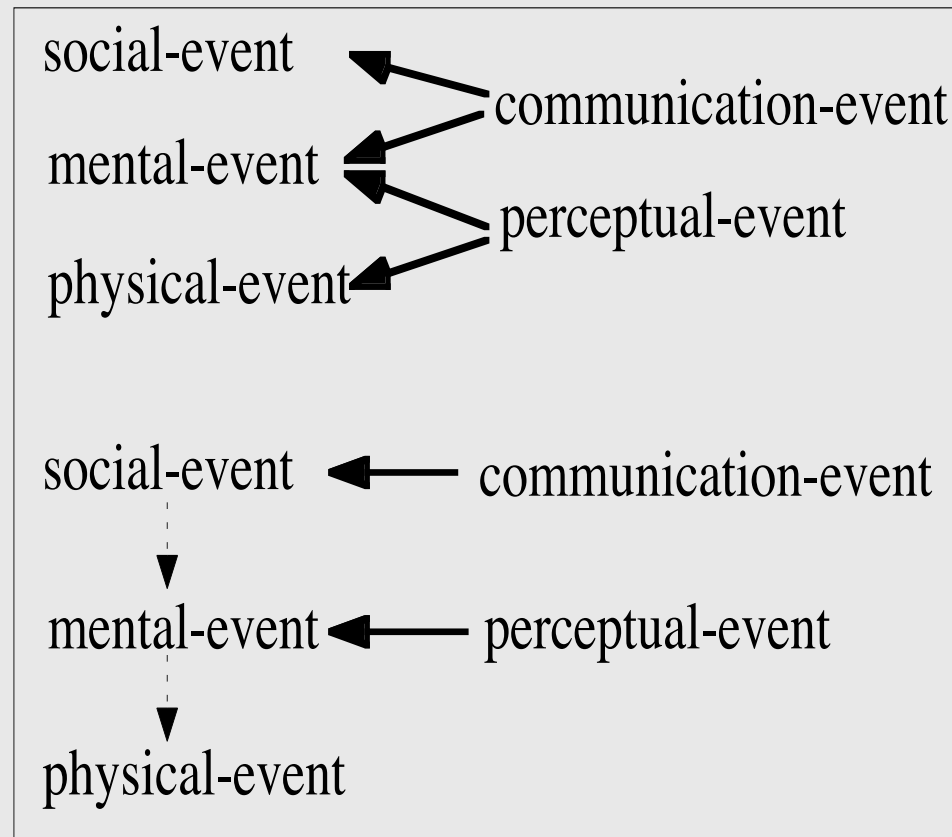
# IS-A overloading

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- ***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* ( $\mu$ Kosmos, WordNet)
- ***Clash of senses:***
  5. A *window* is both an *artifact* and a *place* ( $\mu$ 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* ( $\mu$ Kosmos, Pangloss)



## How ontological levels simplify taxonomies



# The revised TROPOS (meta)model

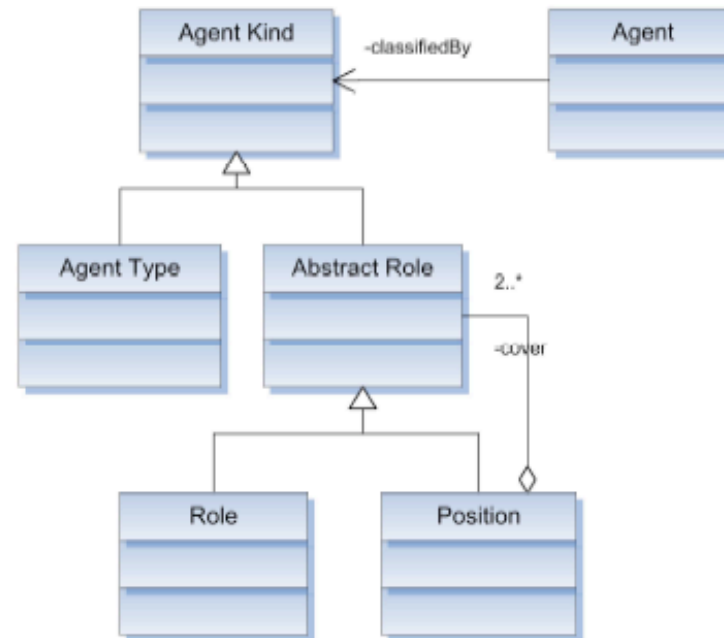
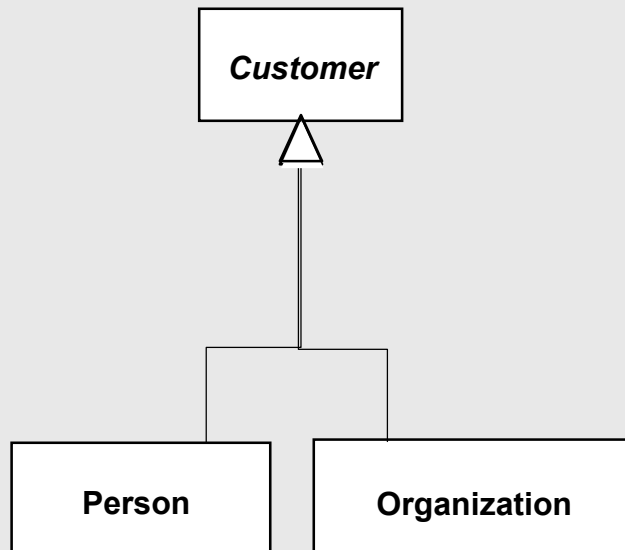


Figure 3.2: Actor metamodel

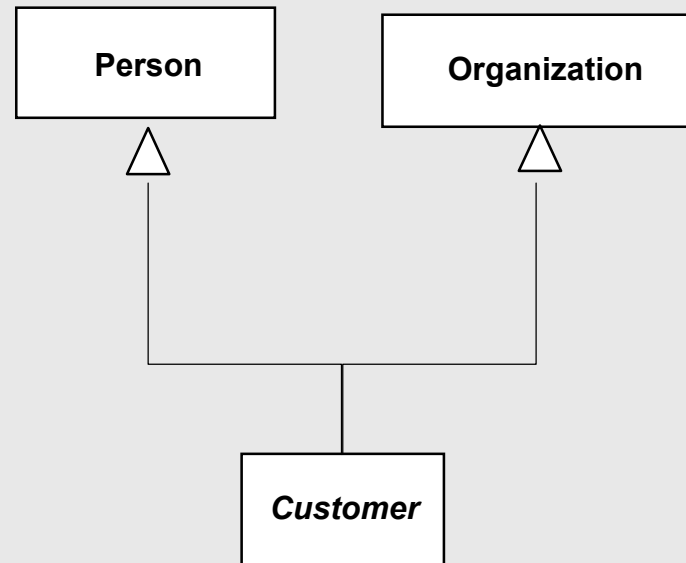


Figure 3.3: Graphical representations of actor and its specializations

# What's the right model?



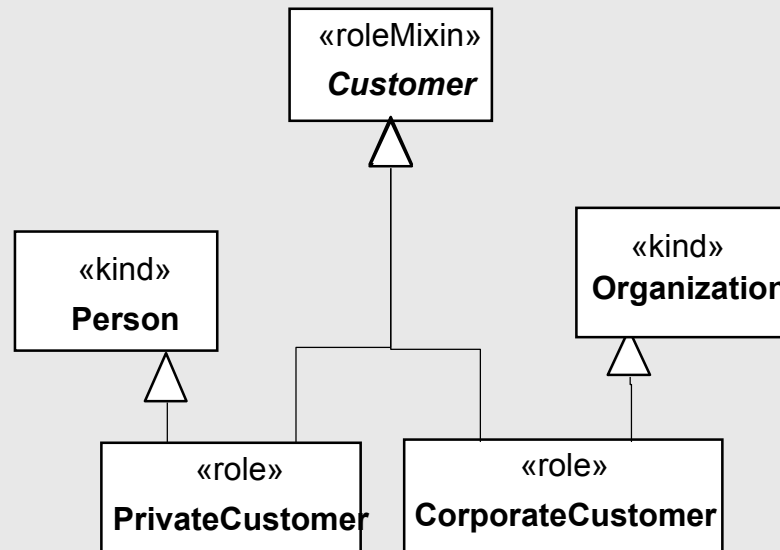
a



b

# The solution [Guizzardi 2005]

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# **A taxonomy cleaning example**



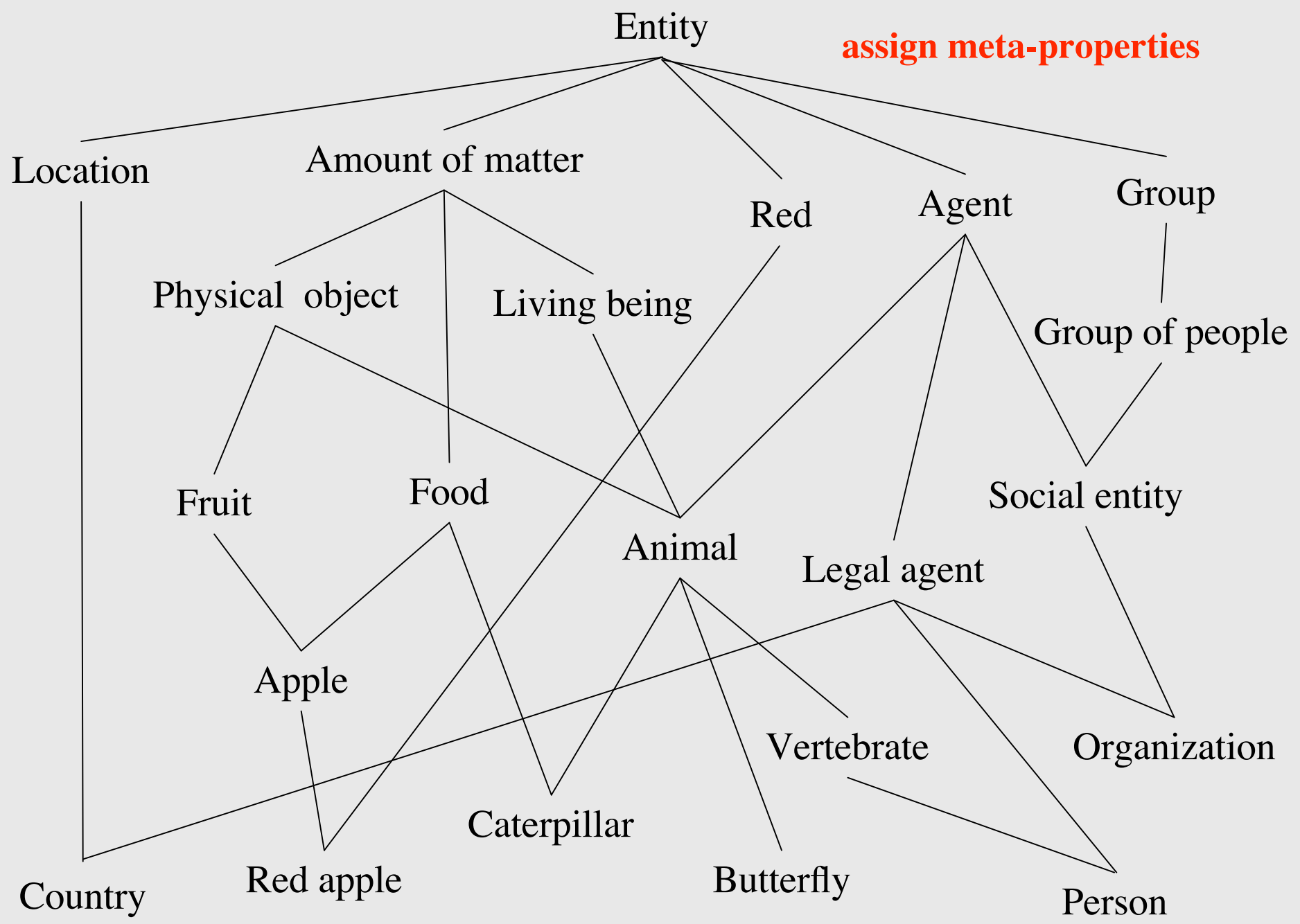
# Taxonomic Constraints

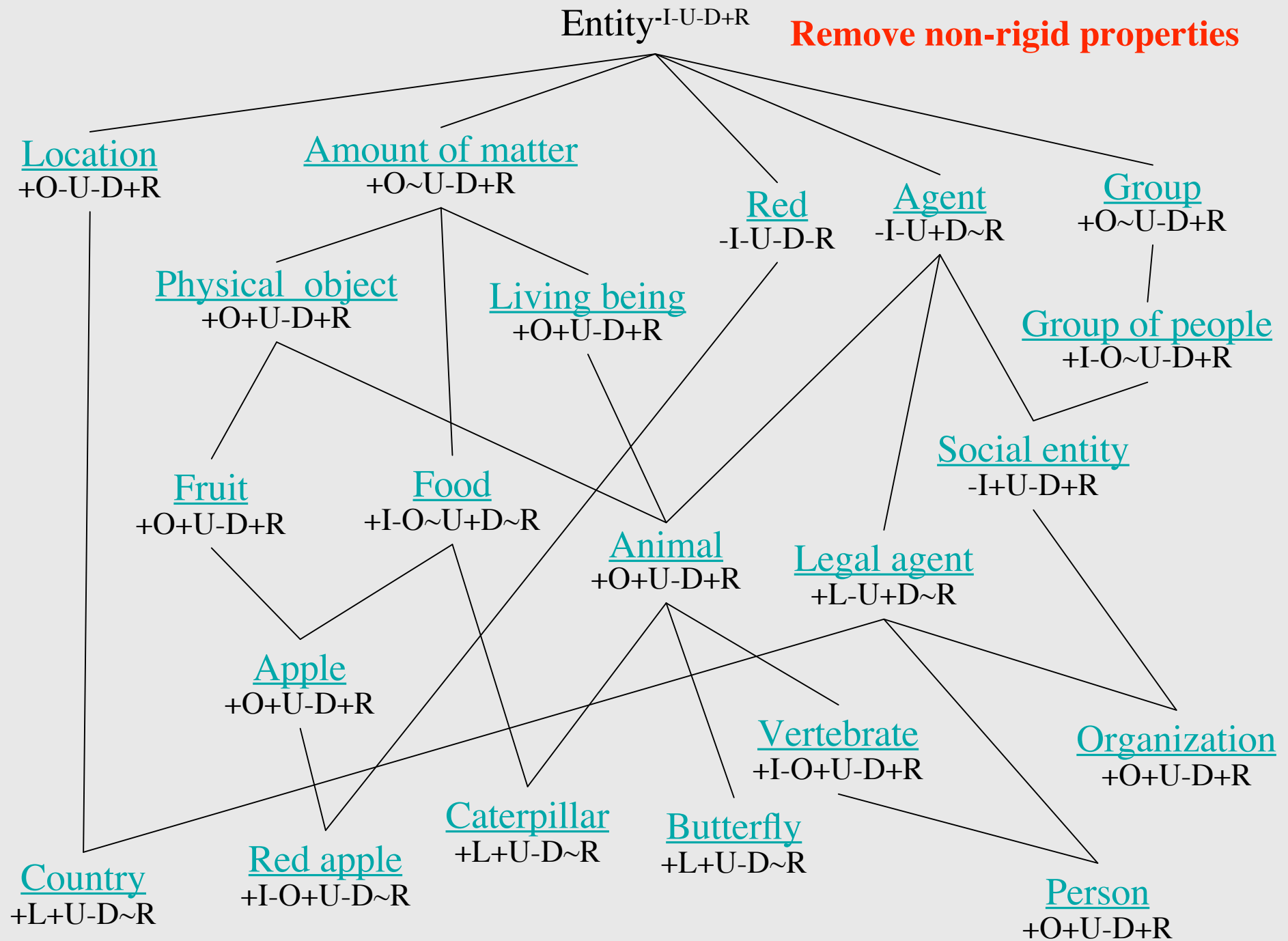
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- $+R \not\subset \sim R$
- $-I \not\subset +I$
- $-U \not\subset +U$
- $+U \not\subset \sim U$
- $-D \not\subset +D$
- Incompatible IC's are disjoint
- Incompatible UC's are disjoint

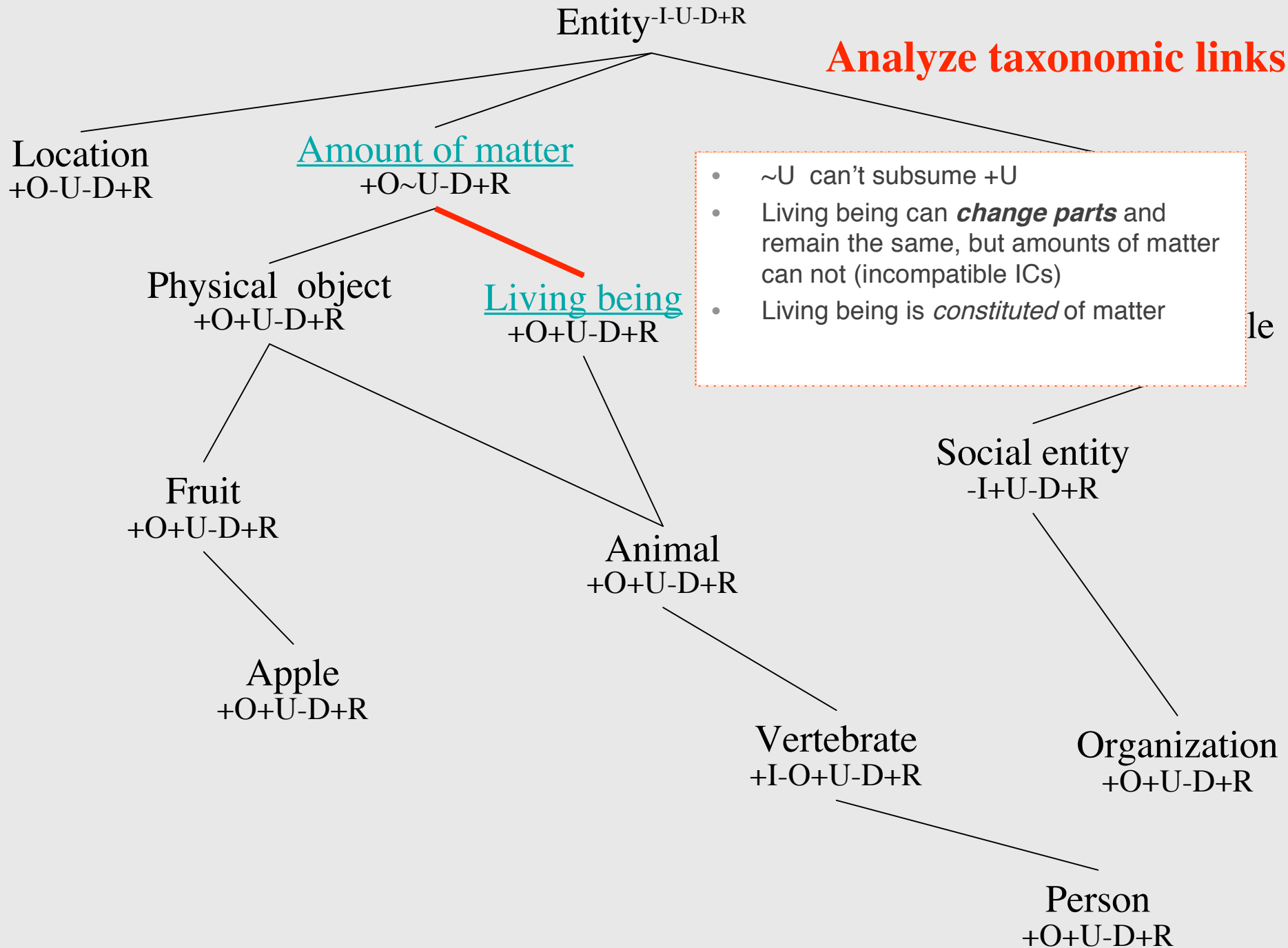


**assign meta-properties**

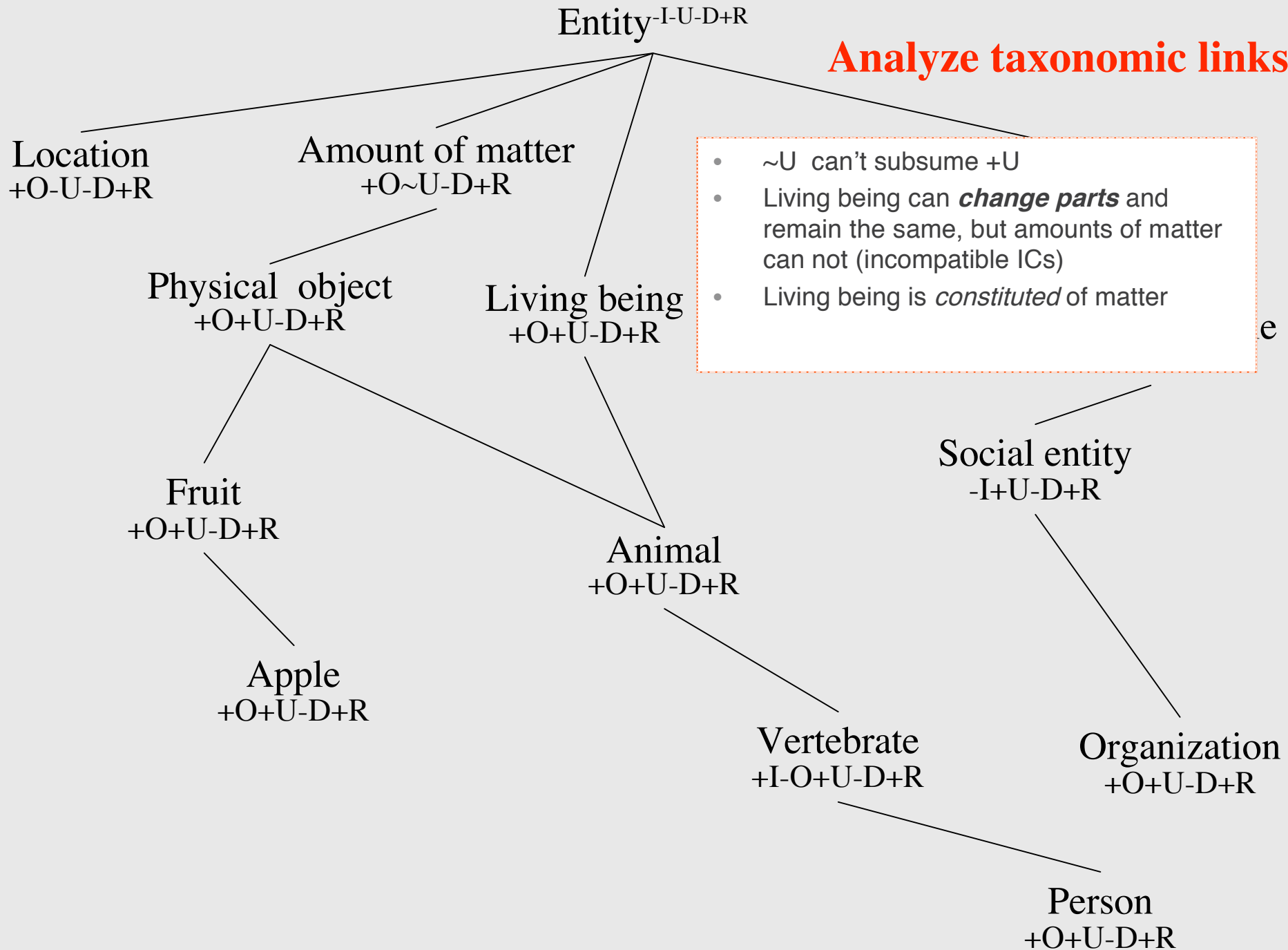




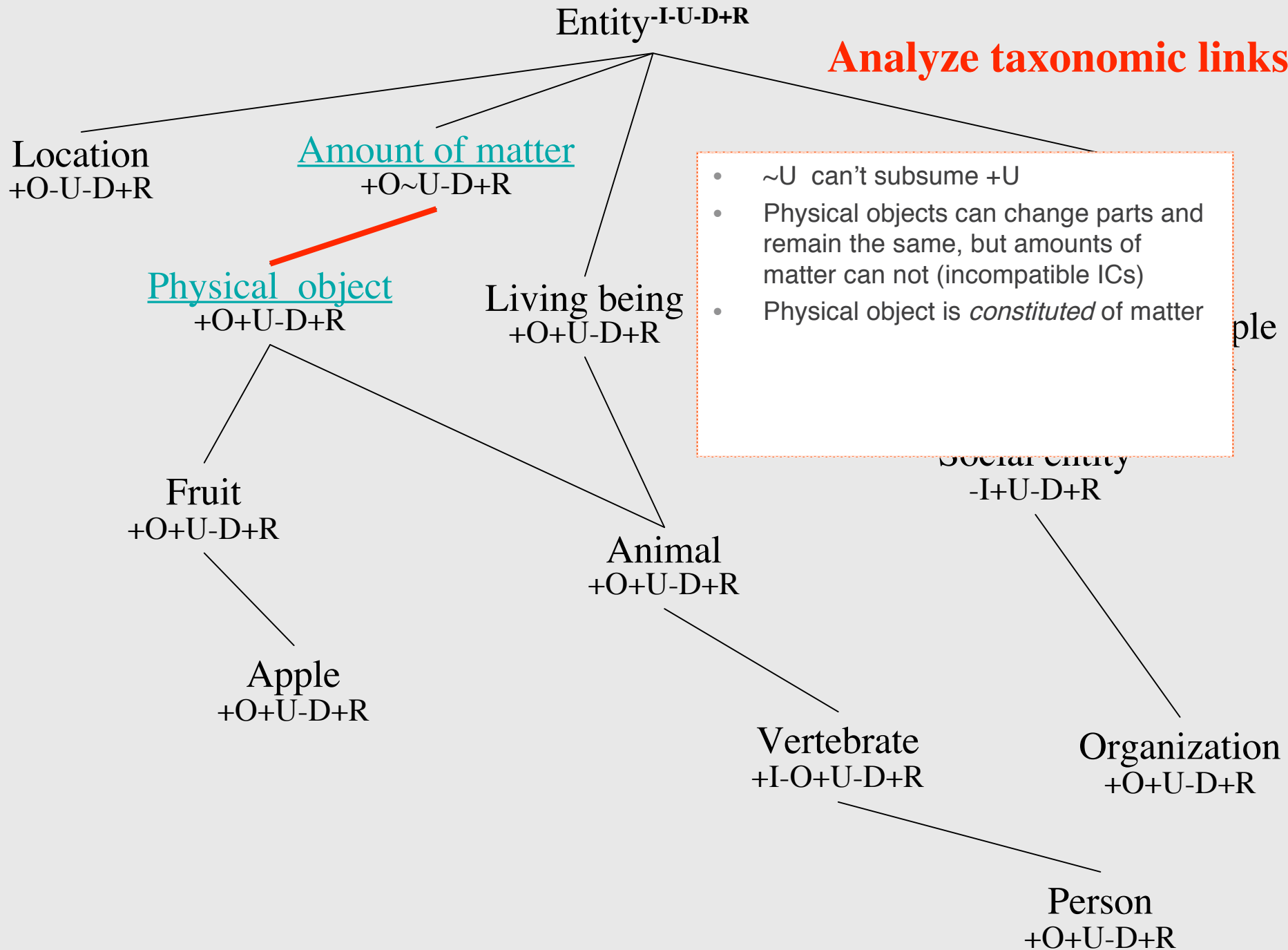
## Analyze taxonomic links



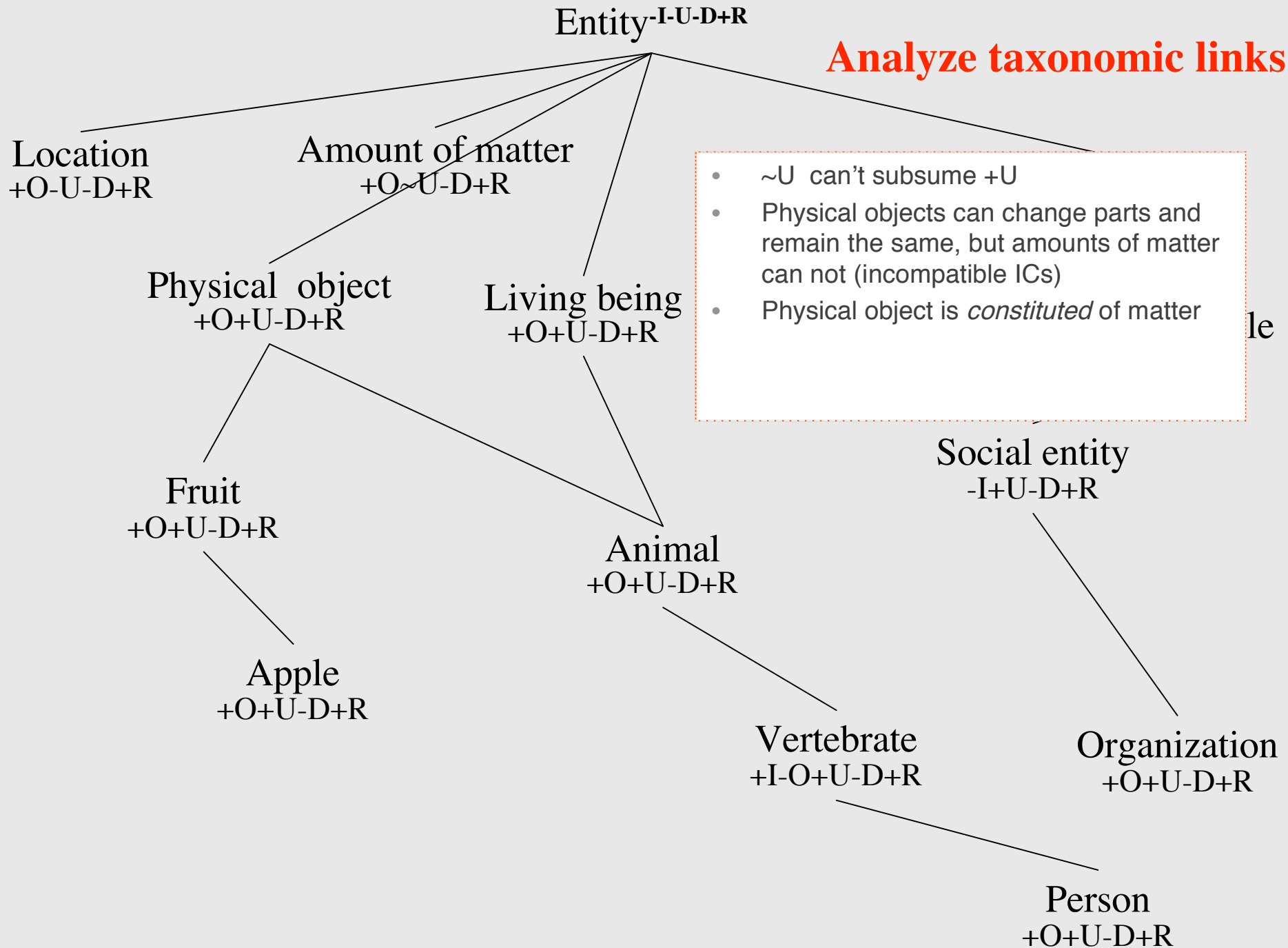
## Analyze taxonomic links



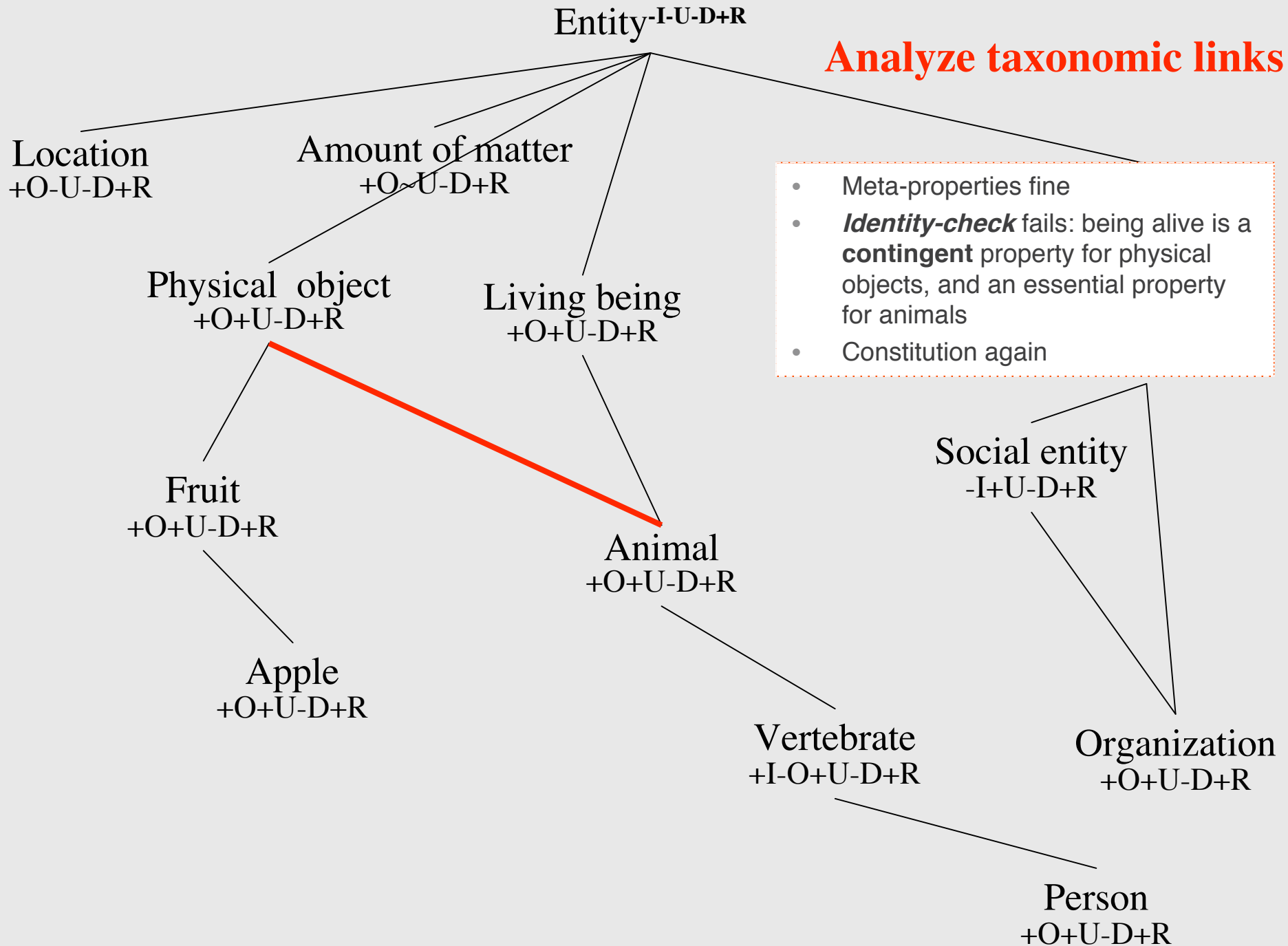
## Analyze taxonomic links



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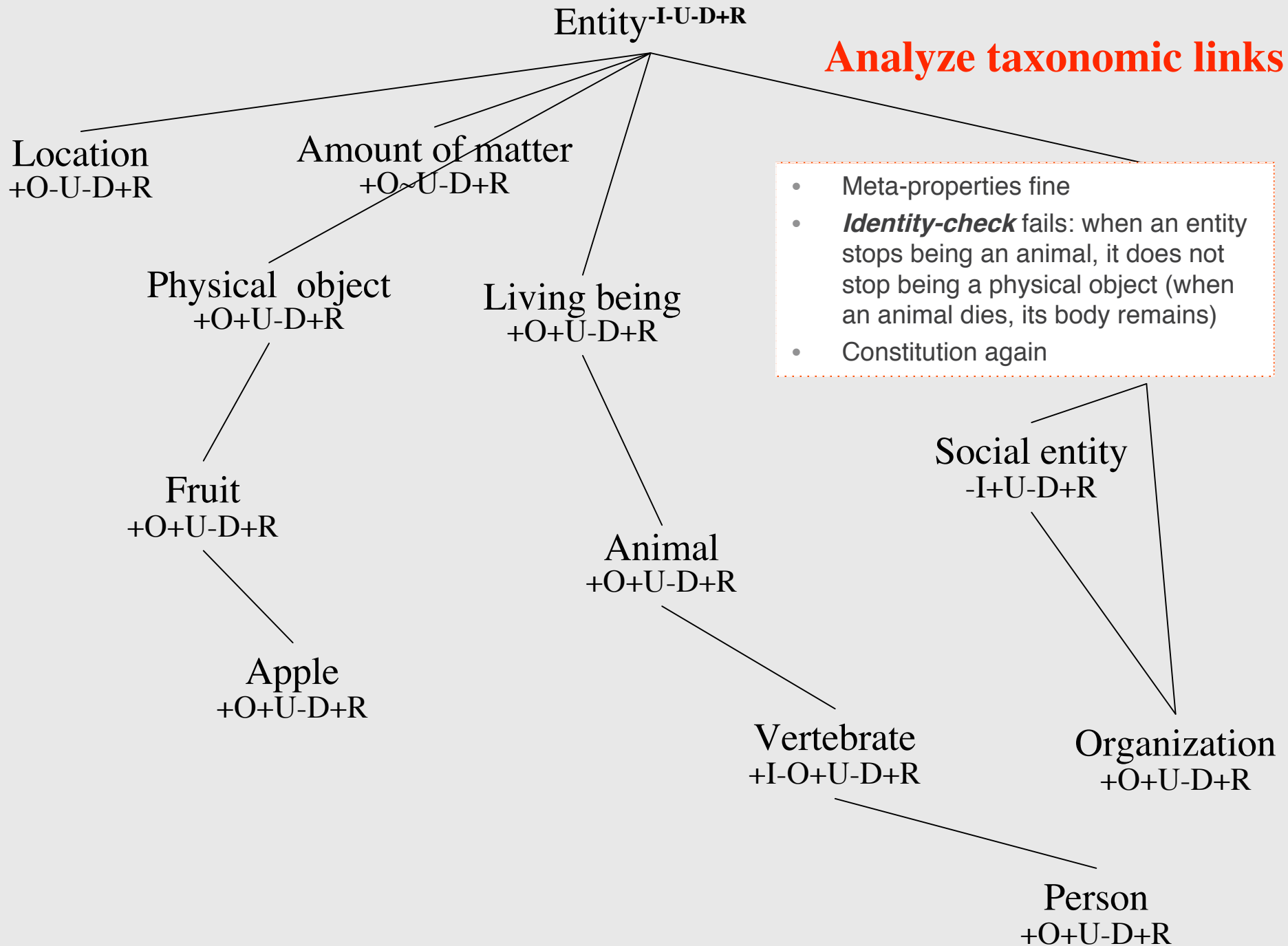


## Analyze taxonomic links

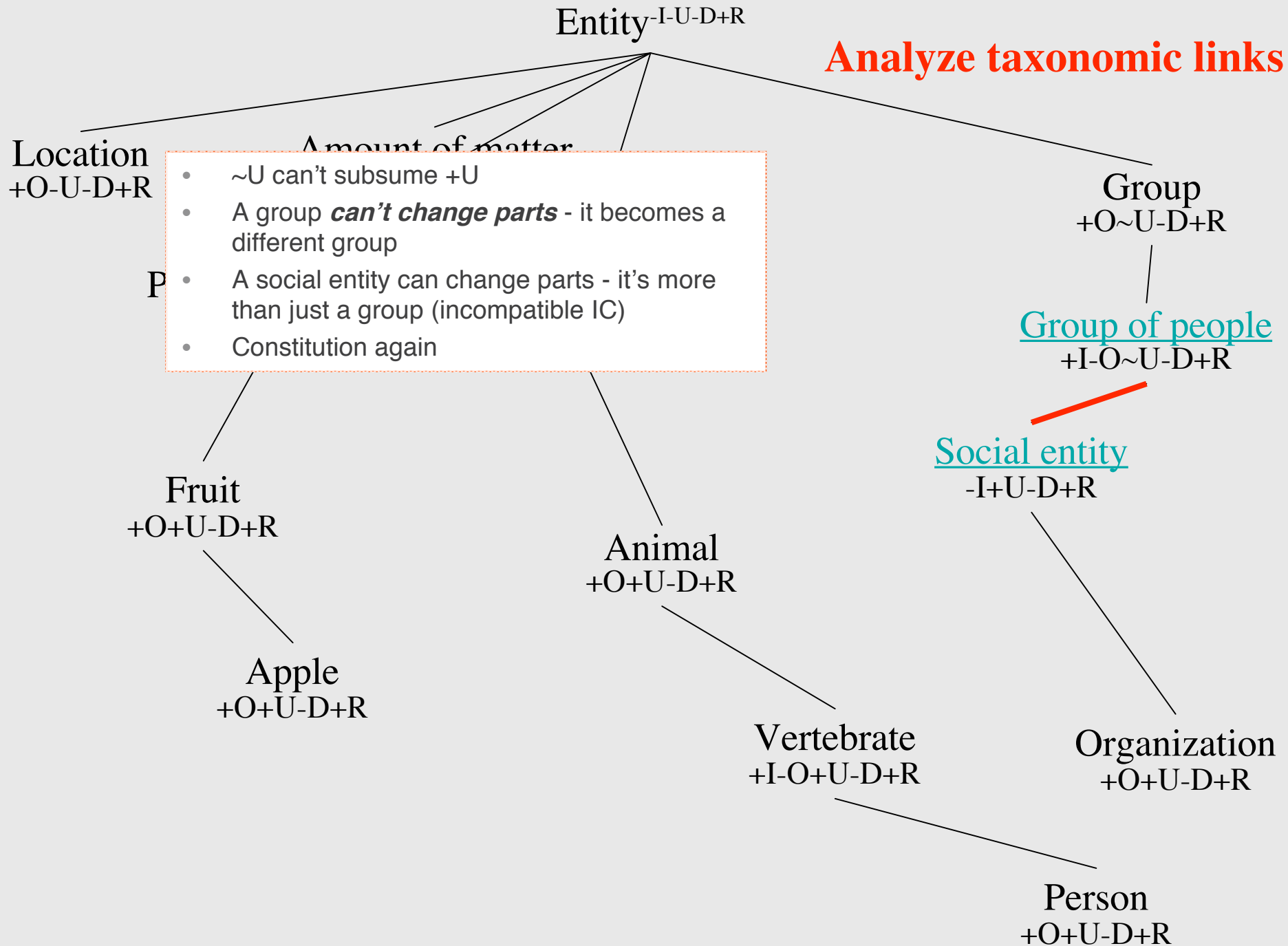


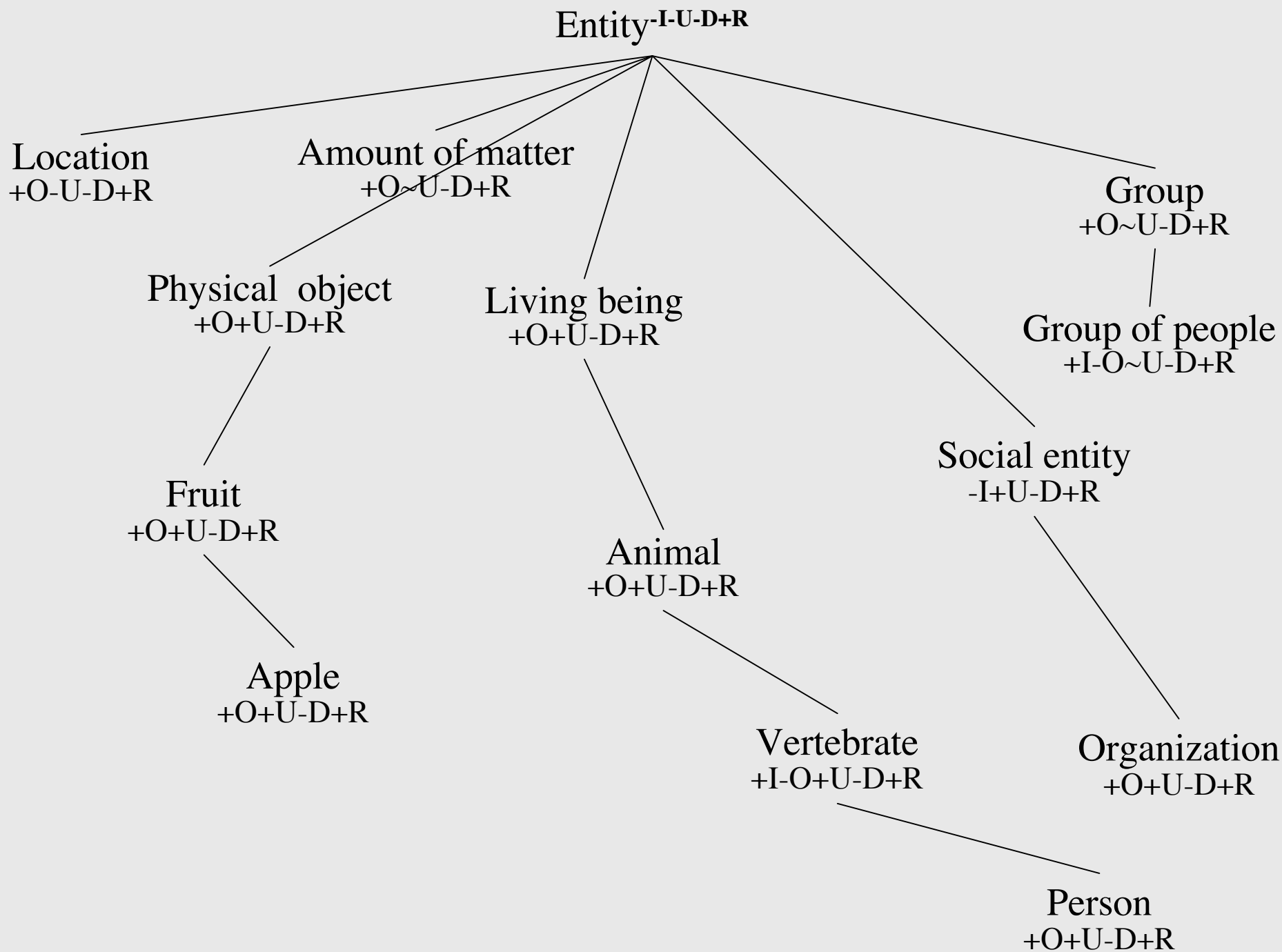


## Analyze taxonomic links

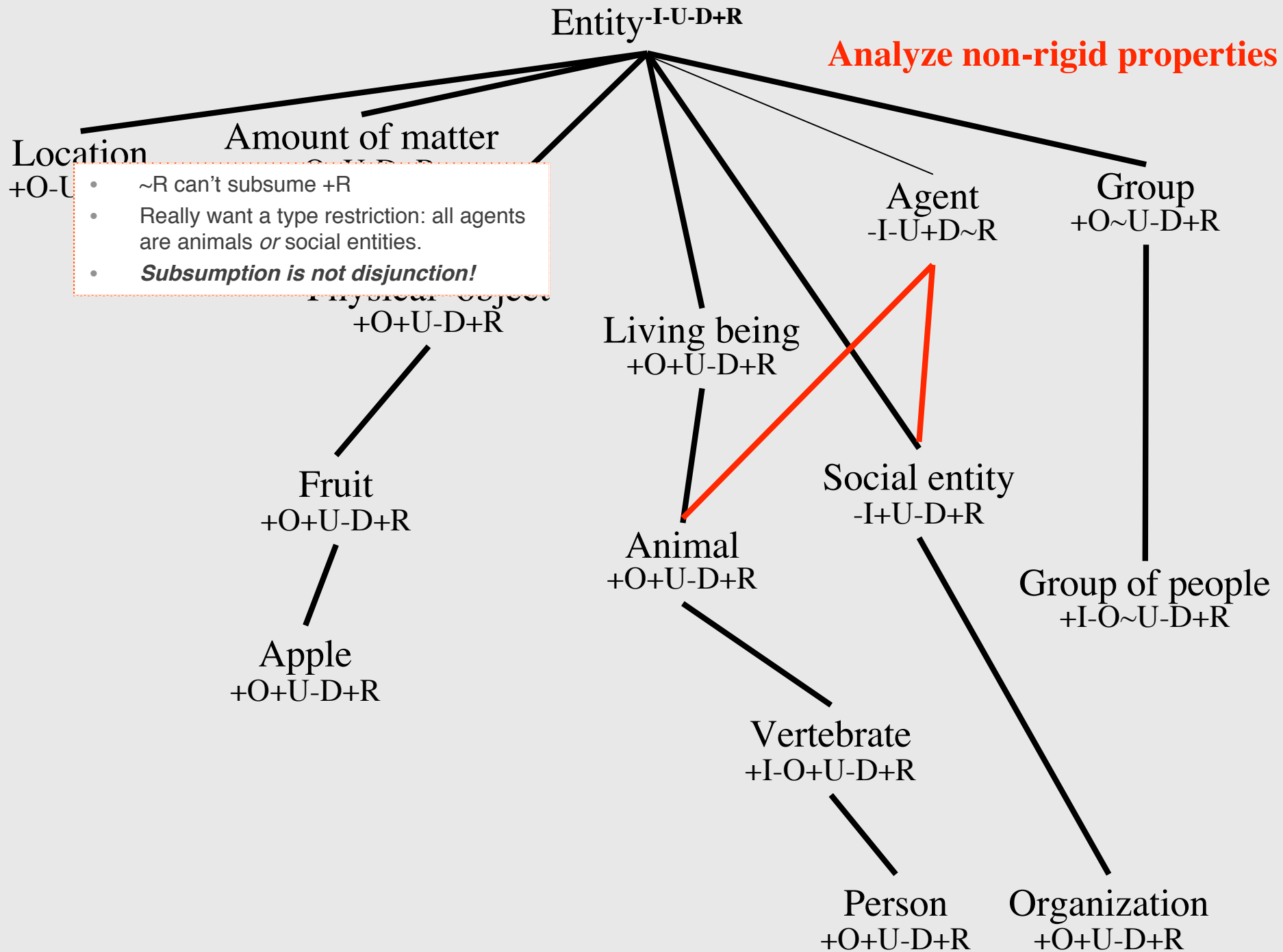


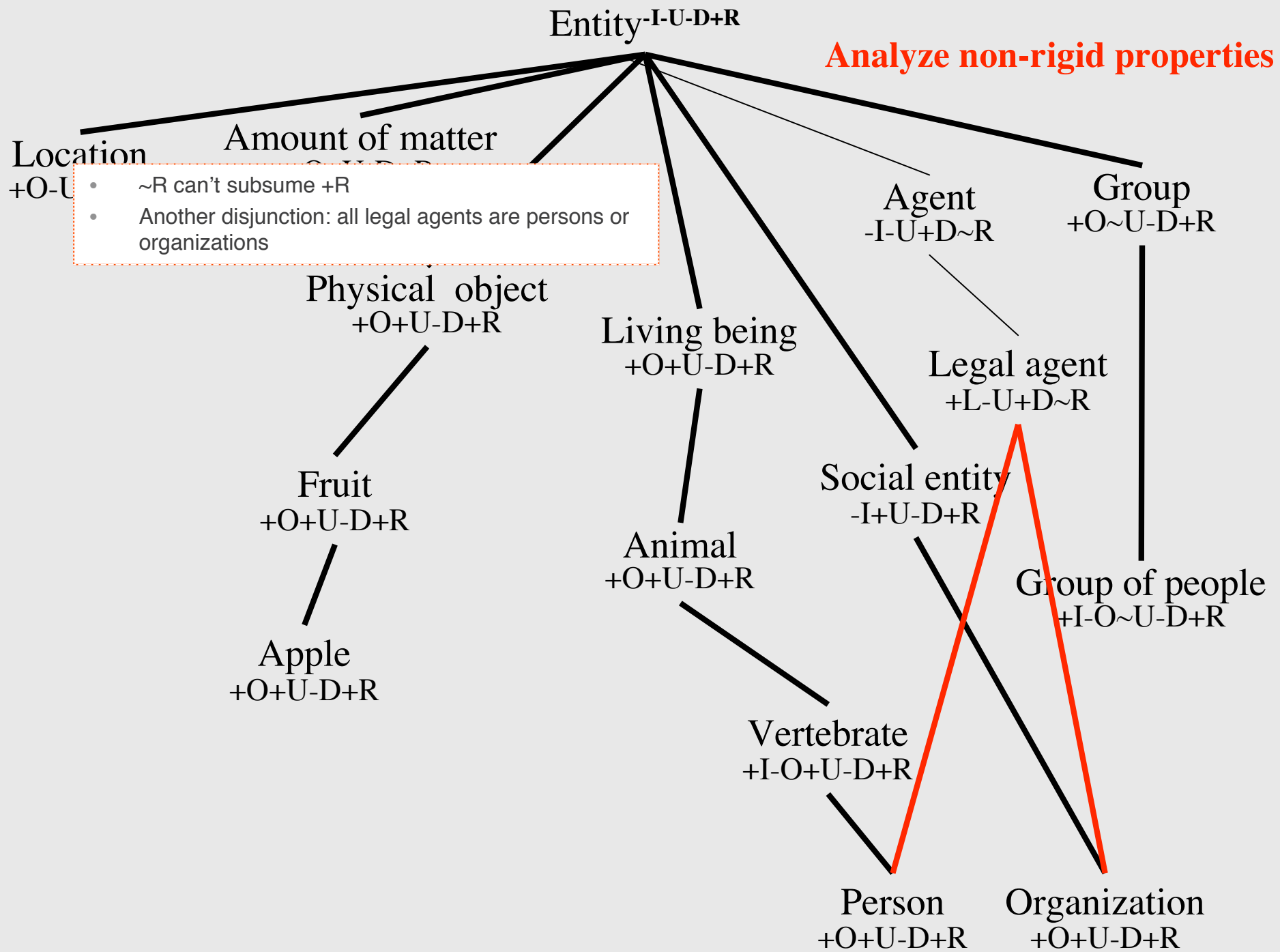
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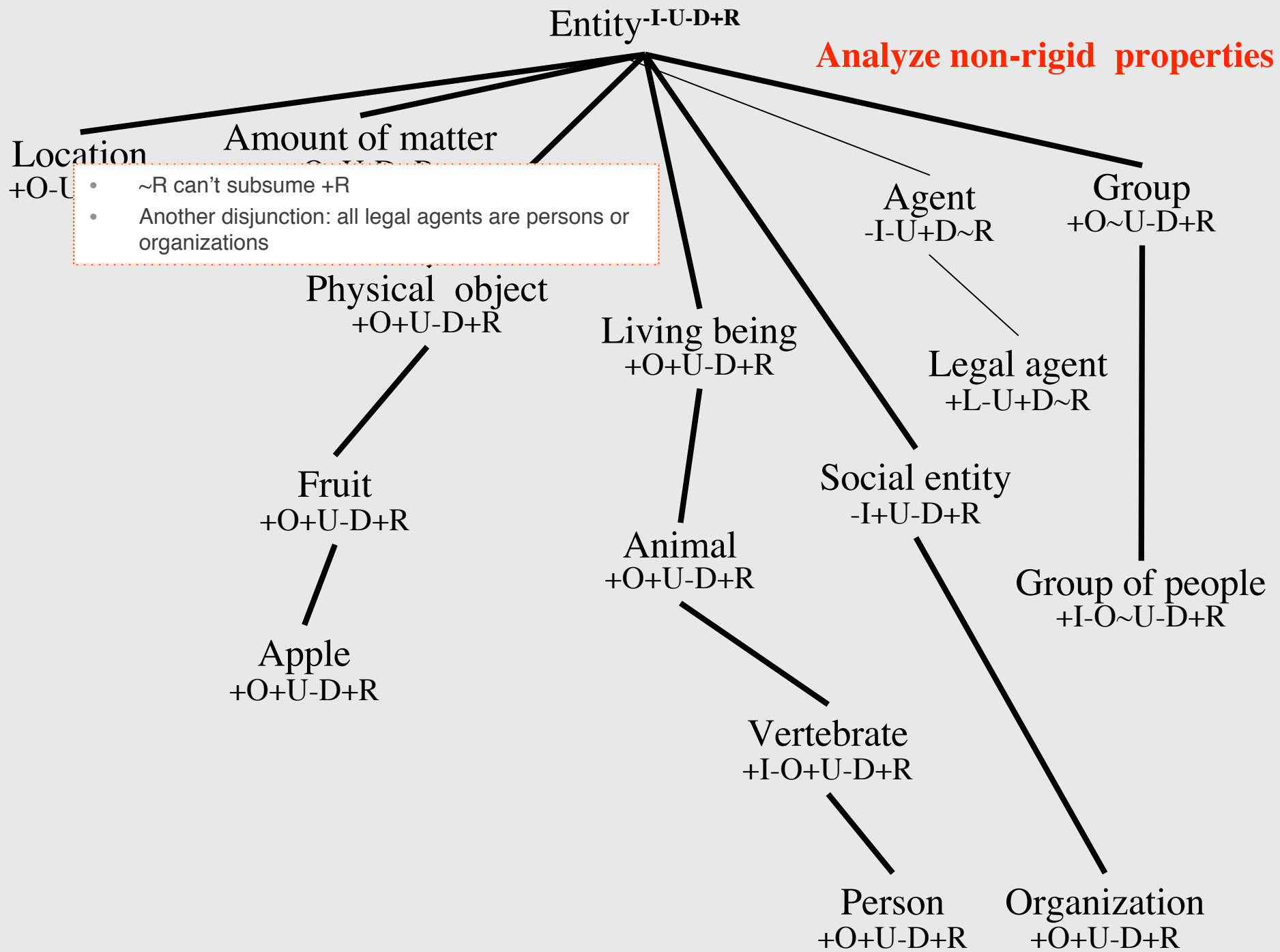




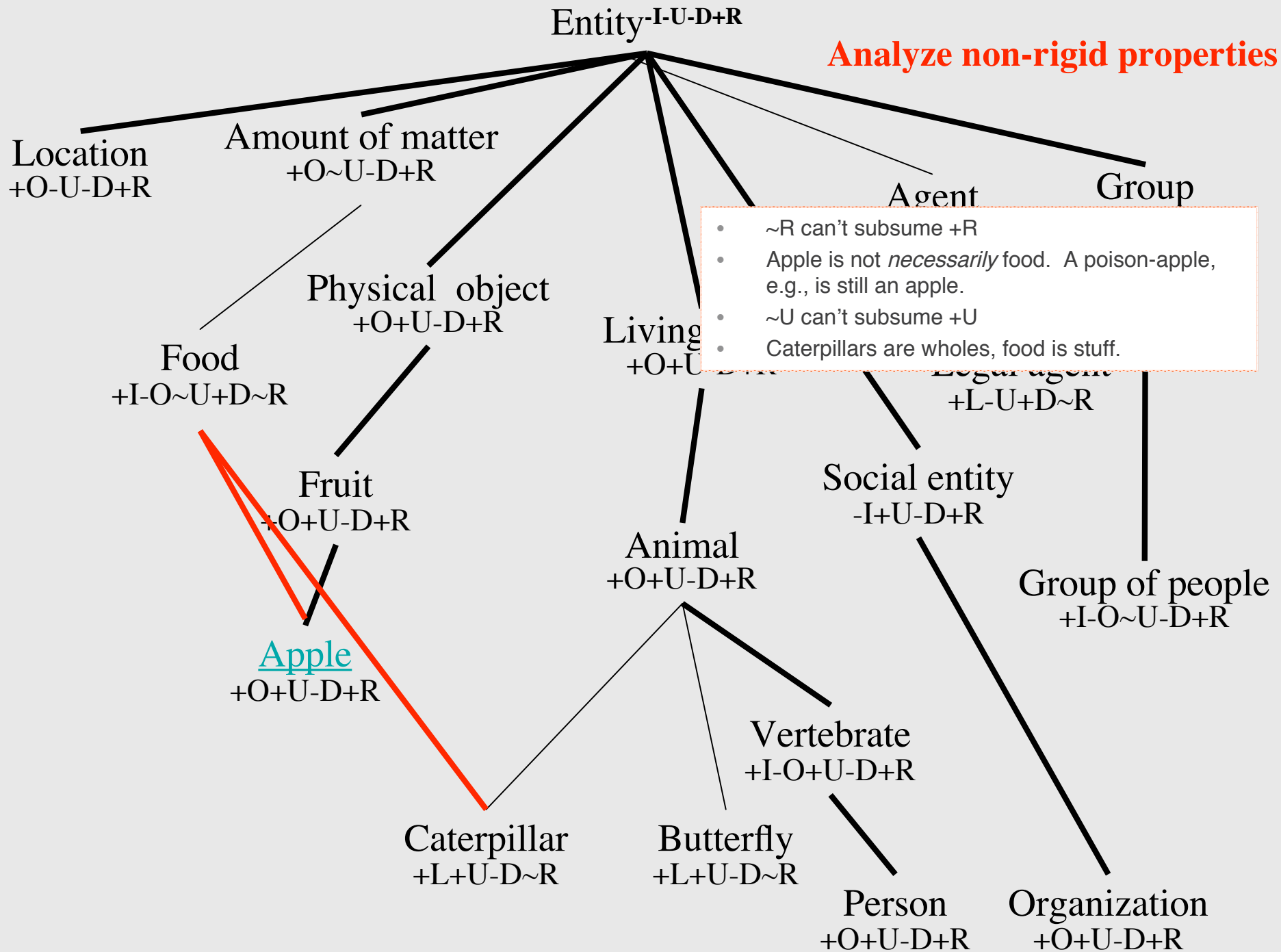
## Analyze non-rigid properties



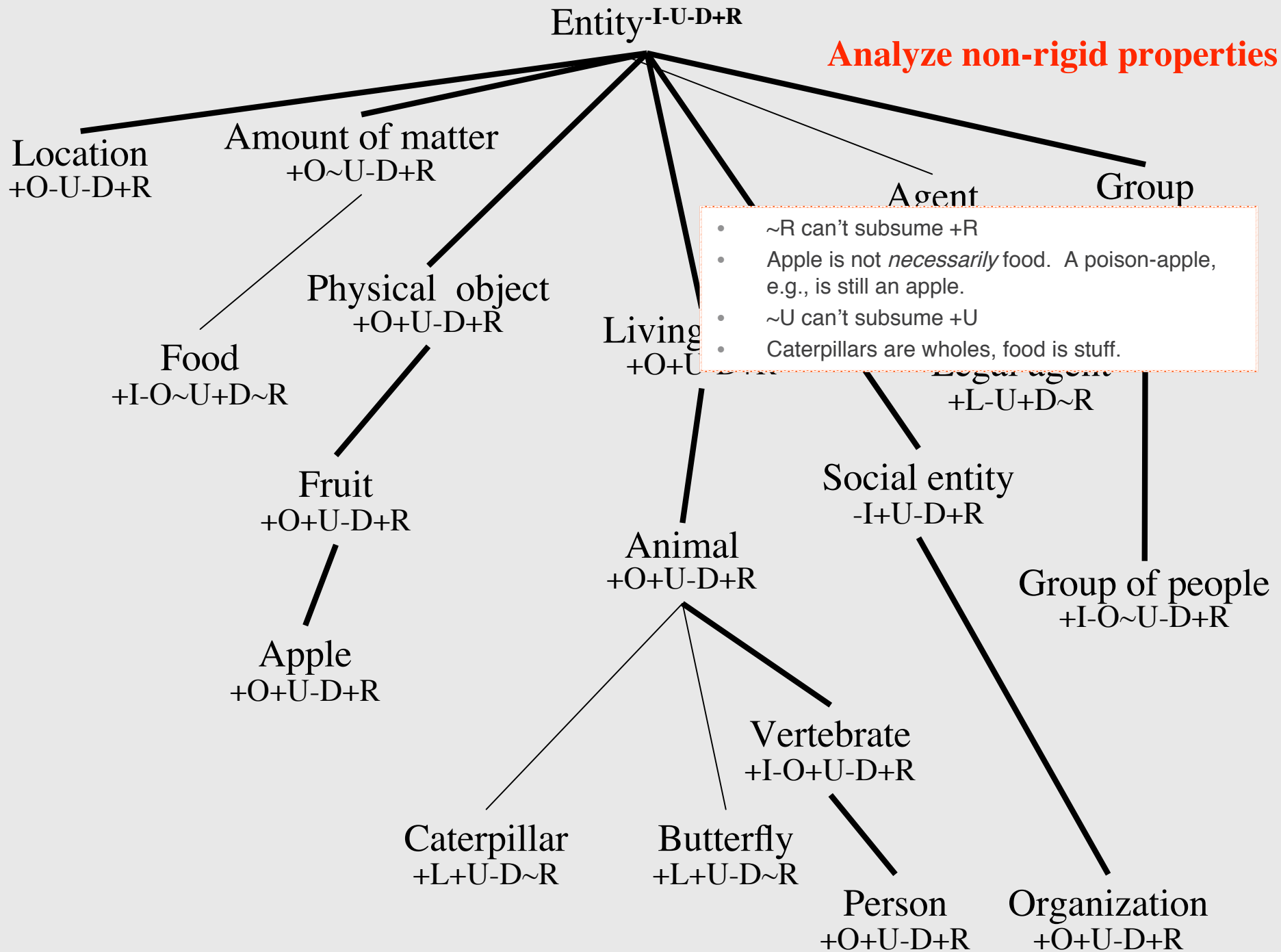




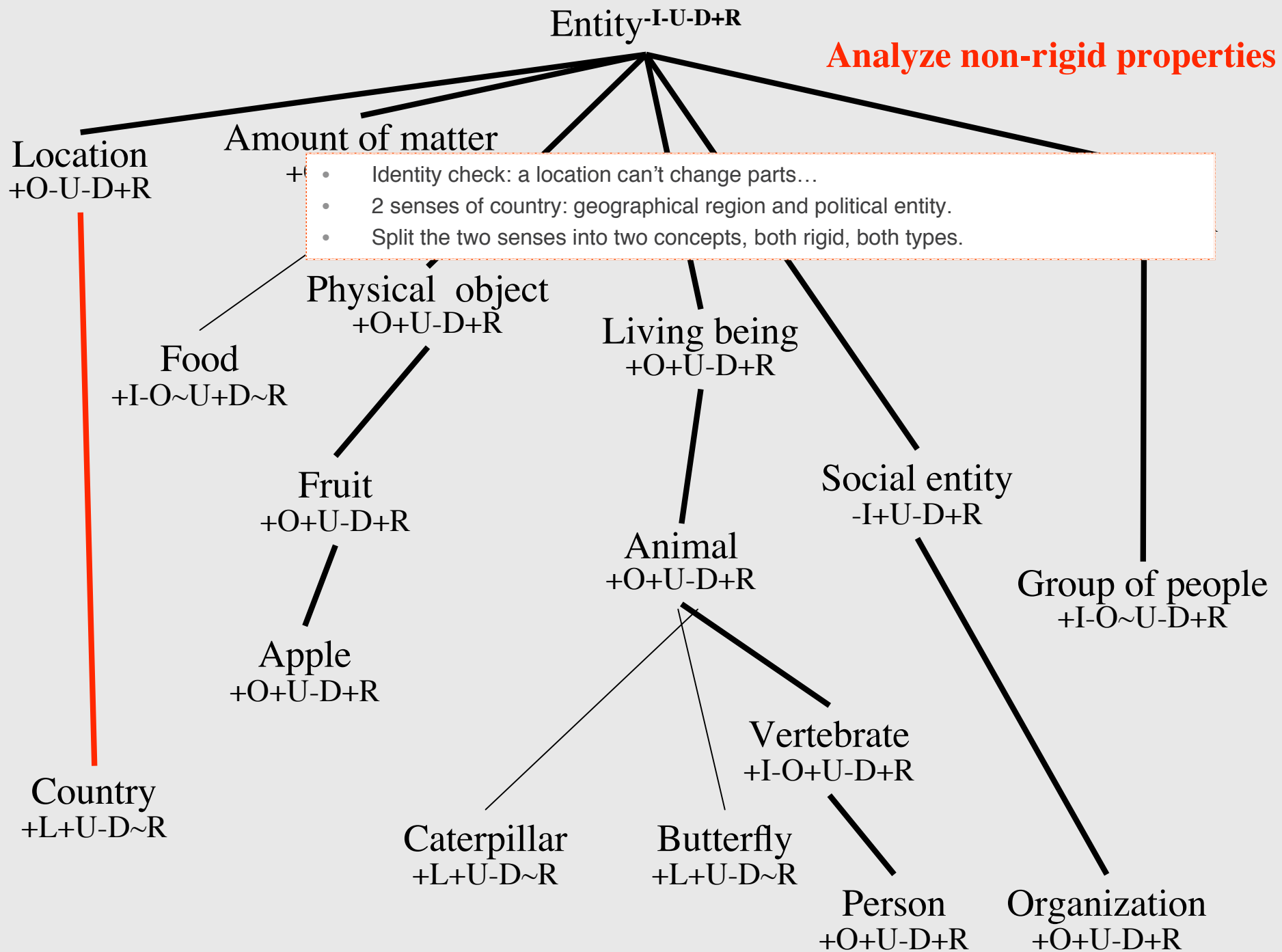
## Analyze non-rigid properties



## Analyze non-rigid properties







Analyze non-rigid properties

Entity -I-U-D+R

Location  
+O-U-D+R

Amount of matter  
+O~U-D+R

Agent  
-I-U+D~R

Group  
+O~U-D+R

There is a relationship between the two,  
but not subsumption.

Food  
+I-O~U+D~R

being  
+O+U-D+R

Legal agent  
+L-U+D~R

Fruit  
+O+U-D+R

Social entity  
-I+U-D+R

Animal  
+O+U-D+R

Group of people  
+I-O~U-D+R

Apple  
+O+U-D+R

Geographical  
Region  
+O-U-D+R

Vertebrate  
+I-O+U-D+R

Country  
+O+U-D+R

Caterpillar  
+L+U-D~R

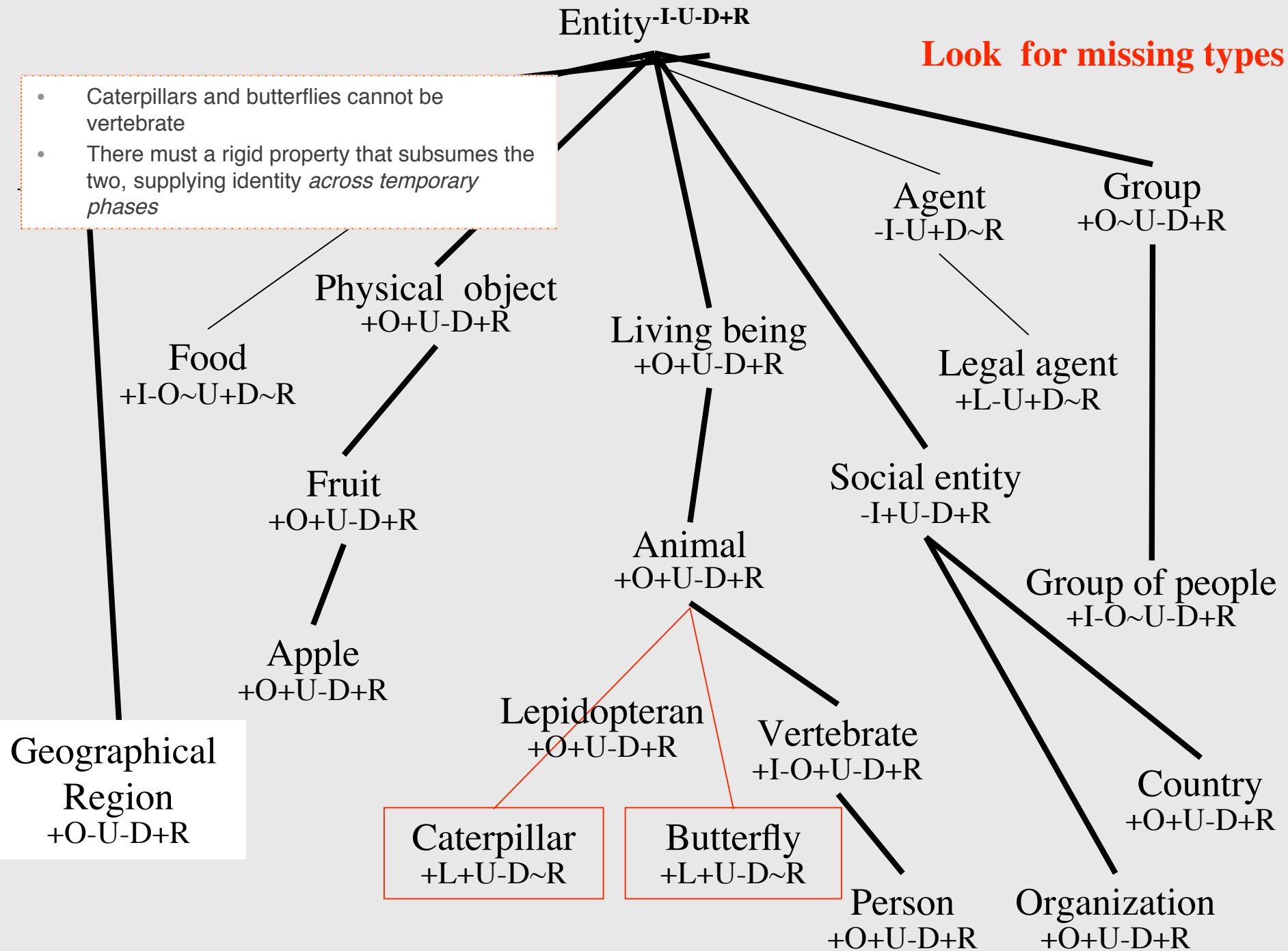
Butterfly  
+L+U-D~R

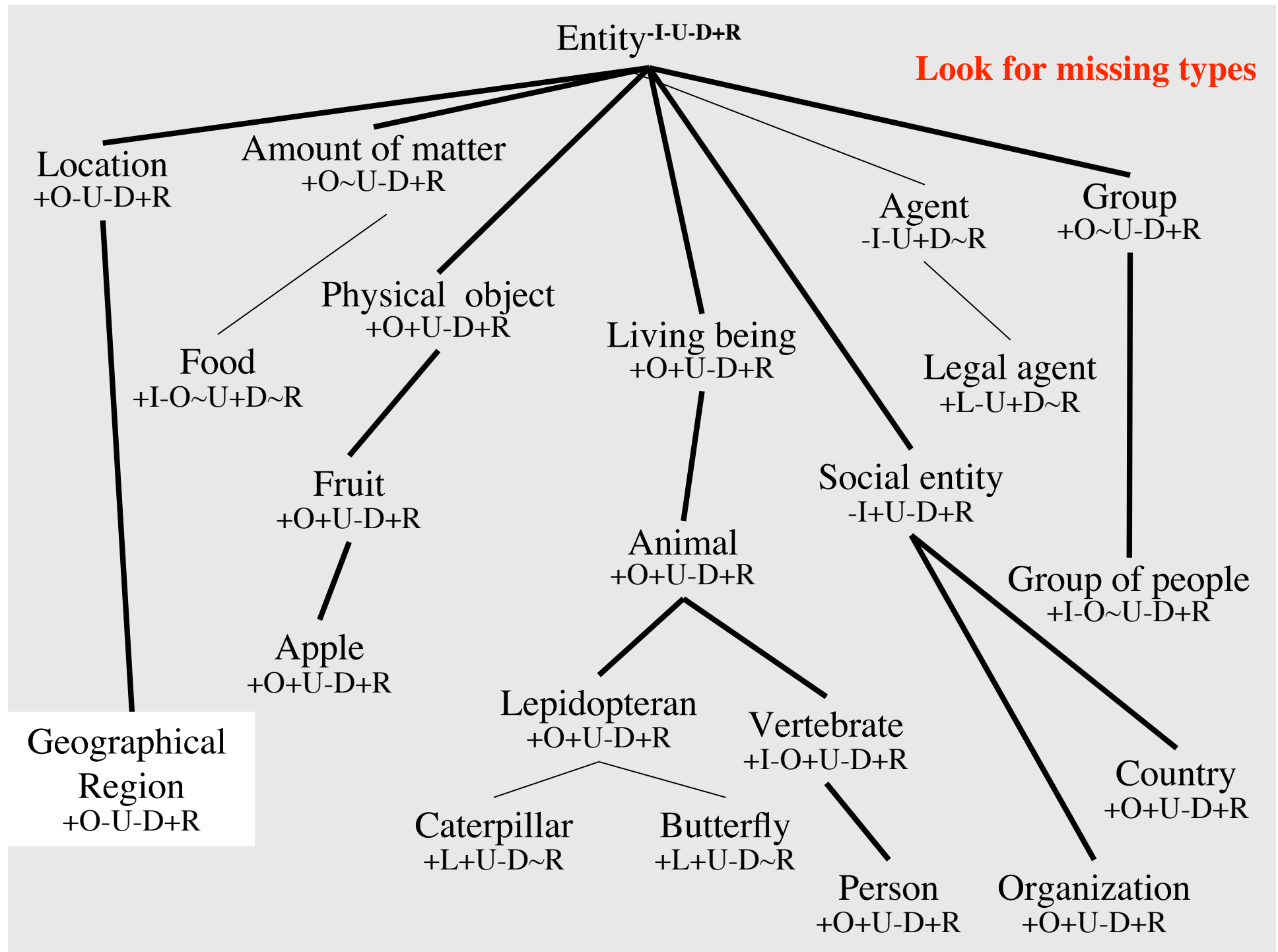
Person  
+O+U-D+R

Organization  
+O+U-D+R

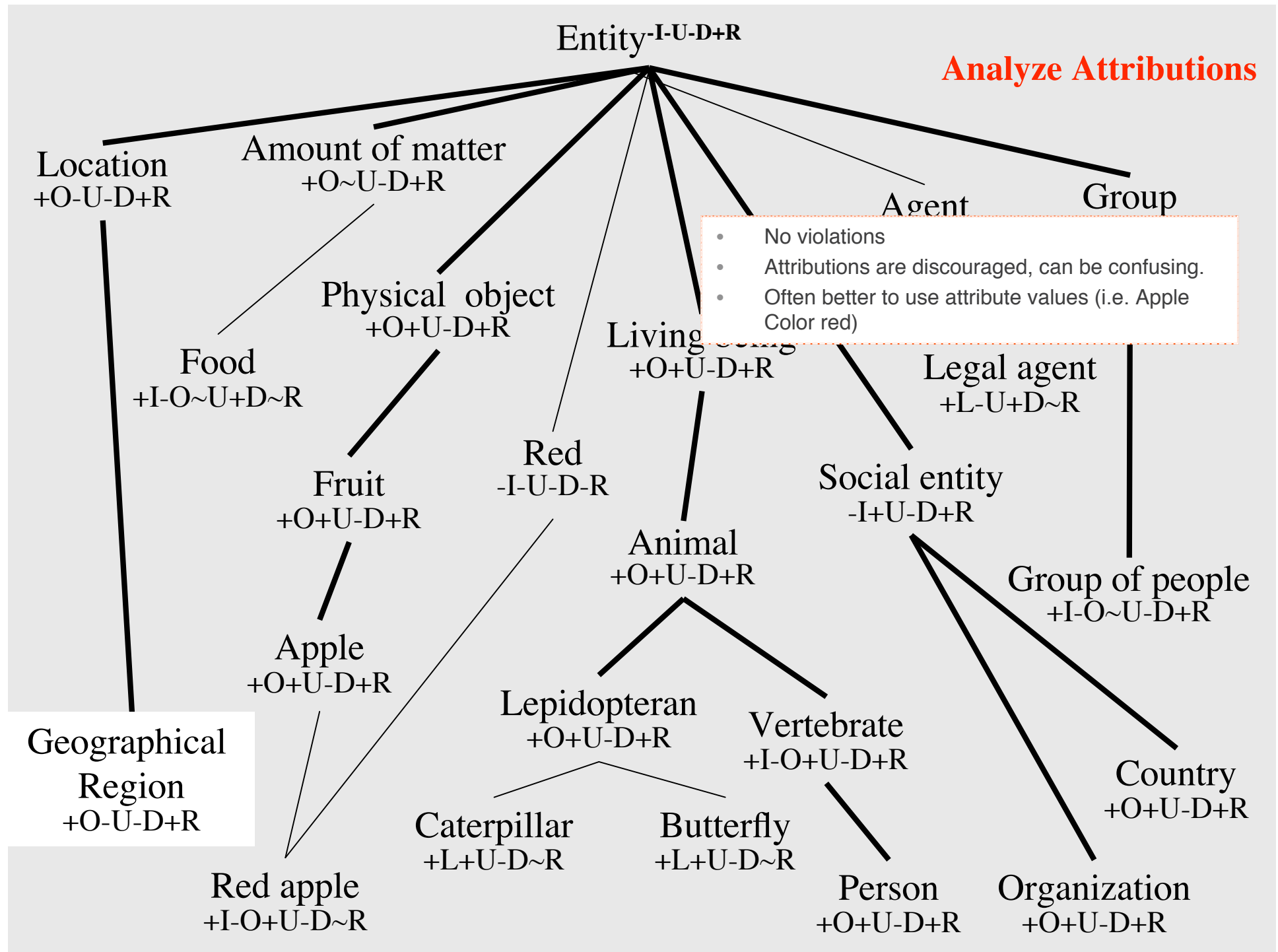
Look for missing types

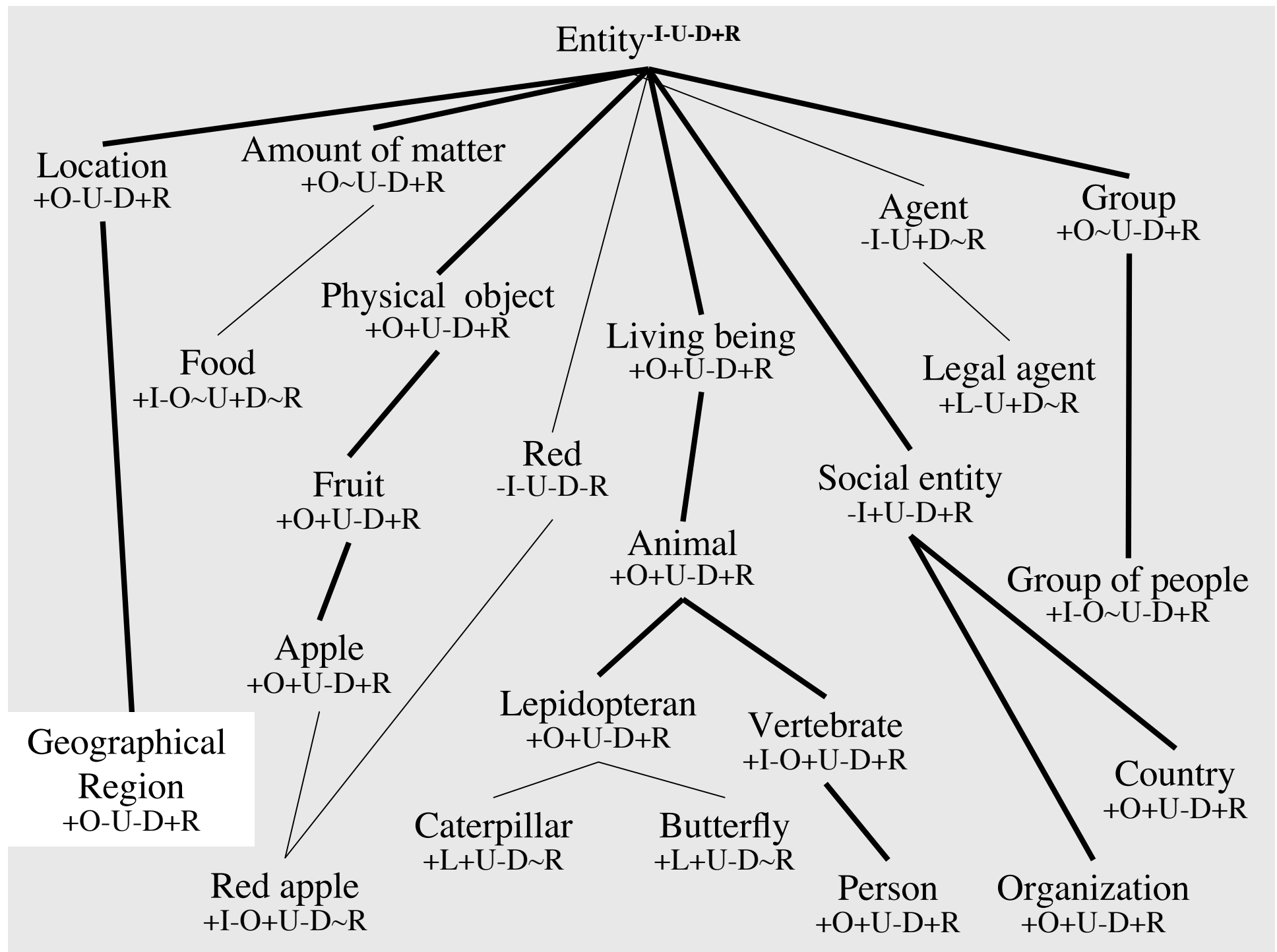
- Caterpillars and butterflies cannot be vertebrate
- There must a rigid property that subsumes the two, supplying identity *across temporary phases*



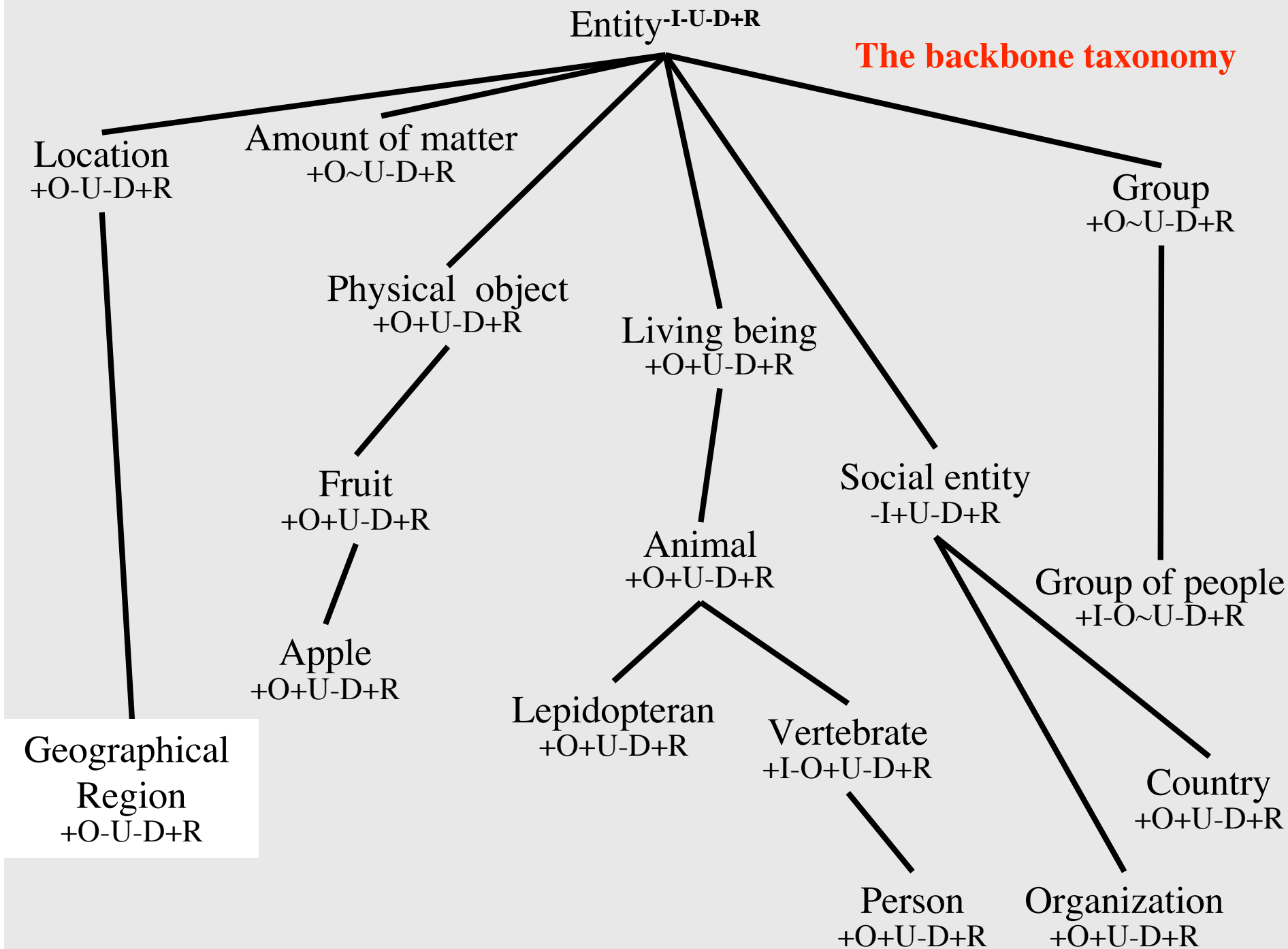


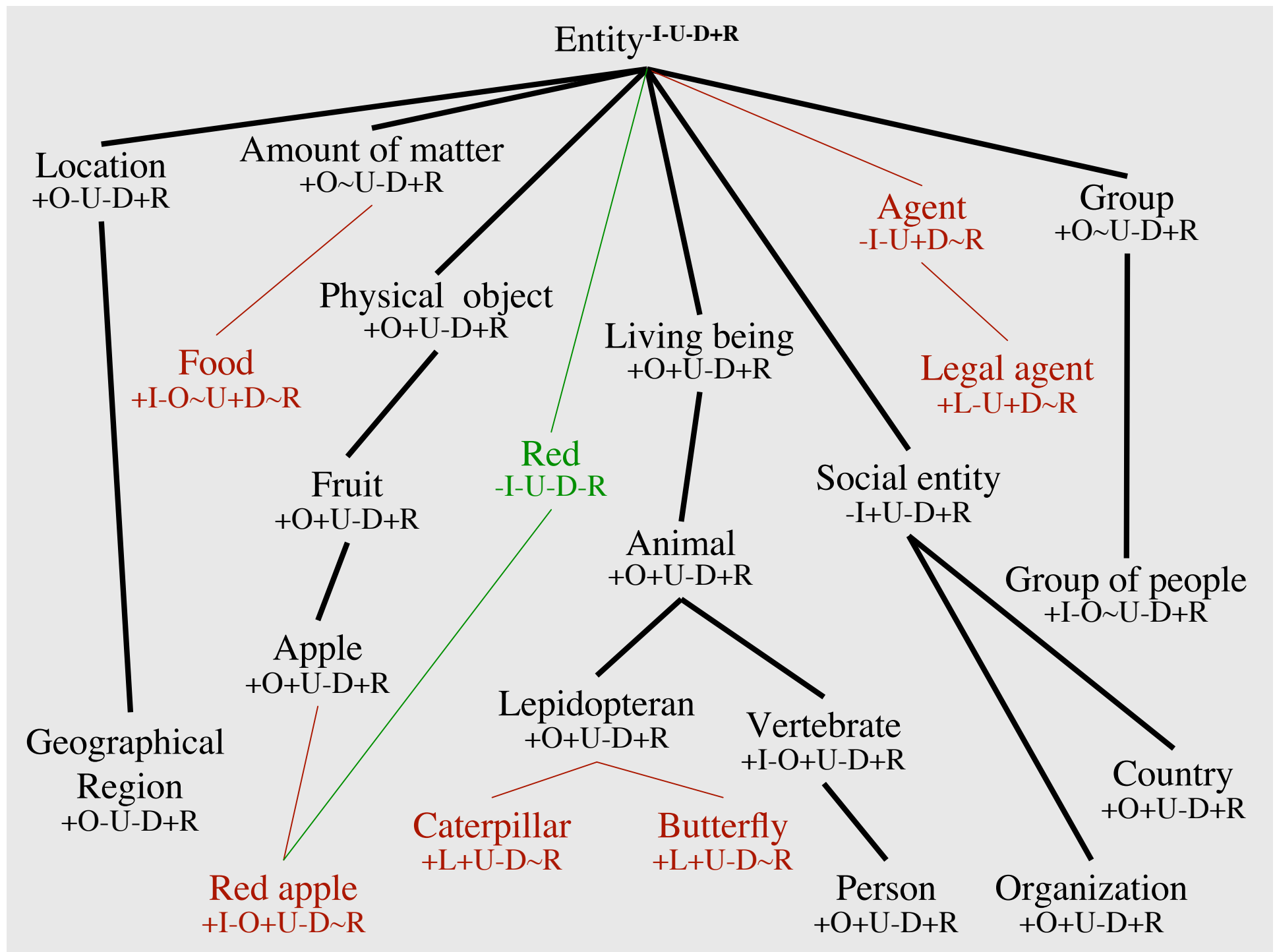
## Analyze Attributions





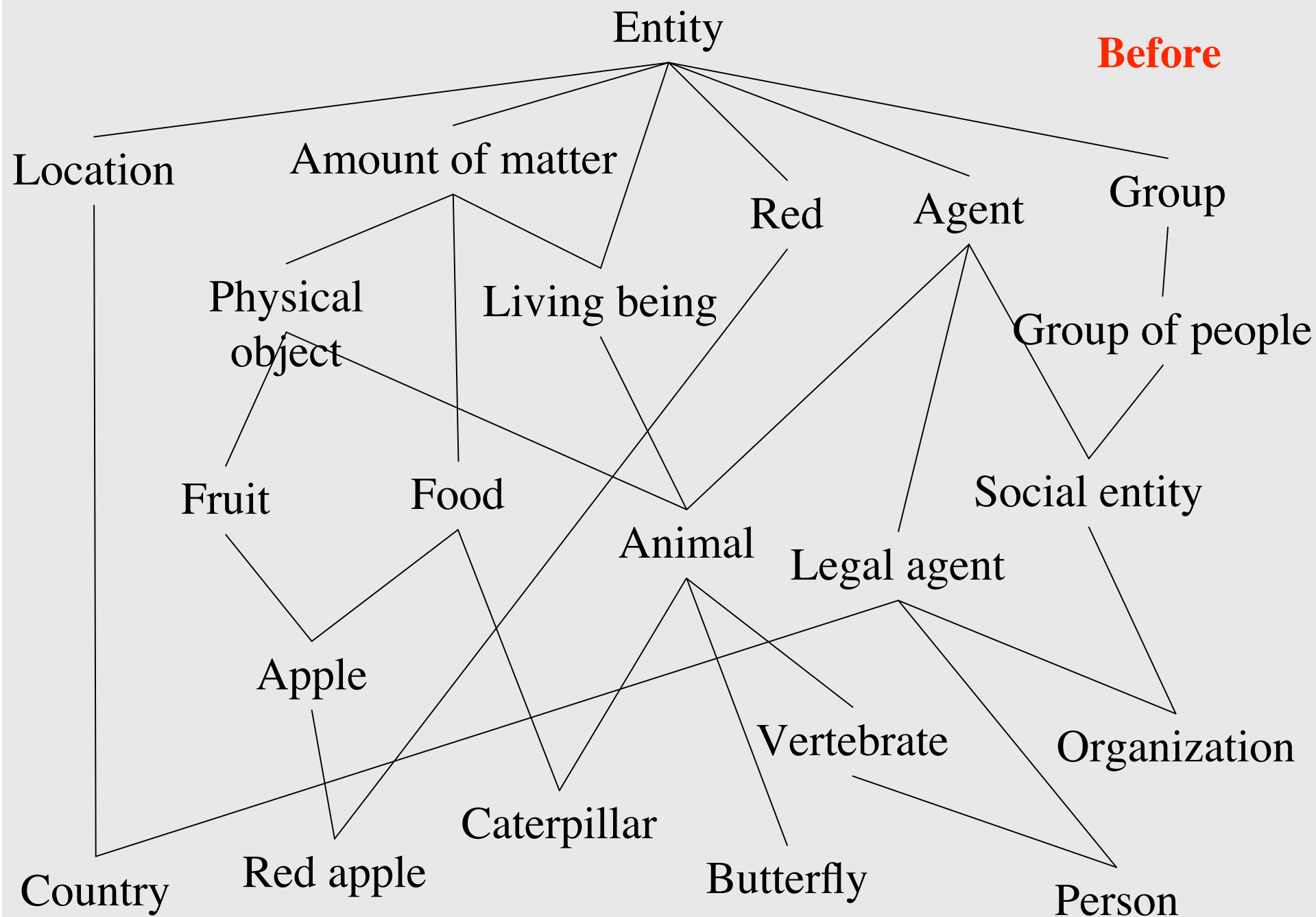
**The backbone taxonomy**







**Before**



After

