When and Why to use a Classifier?

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Reasons to classify (1)

- **Managing Compositional ontologies / Terminologies**
  - **"Conceptual Lego"**
    - **Managing combinatorial explosions - the exploding bicycle**
  - **Empowering users**
    - **"Just in time" ontologies**
      - **Give the users the Lego set with limited connectors**
  - **Organising polyhierarchies / Modularizing ontologies**
    - **"Normalising ontologies"**
    - ***Multiaxial indexing of resources***
  - **Providing multiple views -**
    - ***Reorganising the ontology by new abstractions***
  - **Constraining ontologies & schemas**
    - **Enforcing constraints**
    - **Imposing policies**
      - **For clinical Statements with SNOMED entries in request mode context is request**

Reasons to classify(2)

- ‘Matching’ instances against classes
  - Resource/service discovery
  - Self-describing storage
    - ‘Archetypes’ & templates
- Providing a skeleton for default reasoning & Prototypes (but not to do the reasoning itself)
  - Molluscs typically have shells
    - Cephalopods are kinds of Molluscs but typically do not have shells
      - Nautiloids are kinds of Cephalopods but typically do have shells
        - » Nautilus ancestor are kinds of Nautiloids but do (did) not have shells
  - Biology is full of exceptions

Classification is about Classes

- Classification works for
  - Organising & constraining classes / schemas
  - Identifying the classes to which an instance definitely belongs
    - Or those to which it cannot belong
- Classification is open world
  - Negation as unsatisfiability
    - ‘not’ == ‘impossible’ (“unsatisfiable”)
  - Databases, logic programming, PAL, queries etc are closed world
    - Negation as failure
      - ‘not’ == cannot be found

Reasons not to Classify

- To query large number of instances
  - Open world ("A-Box") reasoning does not work over large numbers of instances
- If the question is closed world
    - E.g. "Drugs licensed for treatment of asthma"
- If the query requires non-DL reasoning
    - E.g. numerical, optimisation, probabilistic, …
      - Would like to have a more powerful hybrid reasoner
- For Metadata and Higher Order Information
  - Classifiers are strictly first order
    - A few things can be 'kluged'
- If there are complex defaults and exceptions
  - "Prototypical Knowledge"
    - E.g. "Molluscs typically have shells"
      - NB Simple exceptions can be handled, but requires care

Use instead

- To query large numbers of instances OR
  If the query is closed world
  - Queries / constraints over databases
  - Instance stores / triple stores / …
  - Rules
    - DL-programming
    - JESS, Algernon, Prolog, …
  - Belief revision / non-monotonic reasoning
- If query requires Non DL Reasoning
  - Hybrid reasoners or ?SWRL?
    - No good examples at the moment
- For defaults and Exceptions & Prototypical Knowledge
  - Traditional frame systems
    - More expressive default structure than Protégé
      - Exceptions for classes as well as instances
        - » Over-riding rather than narrowing

Classification to build Ontologies: Conceptual Lego

hand

extremity

body

chronic

acute

abnormal

normal

ischaemic

deletion

polymorphism

gene

protein

cell

expression

Lung

inflammation

infection

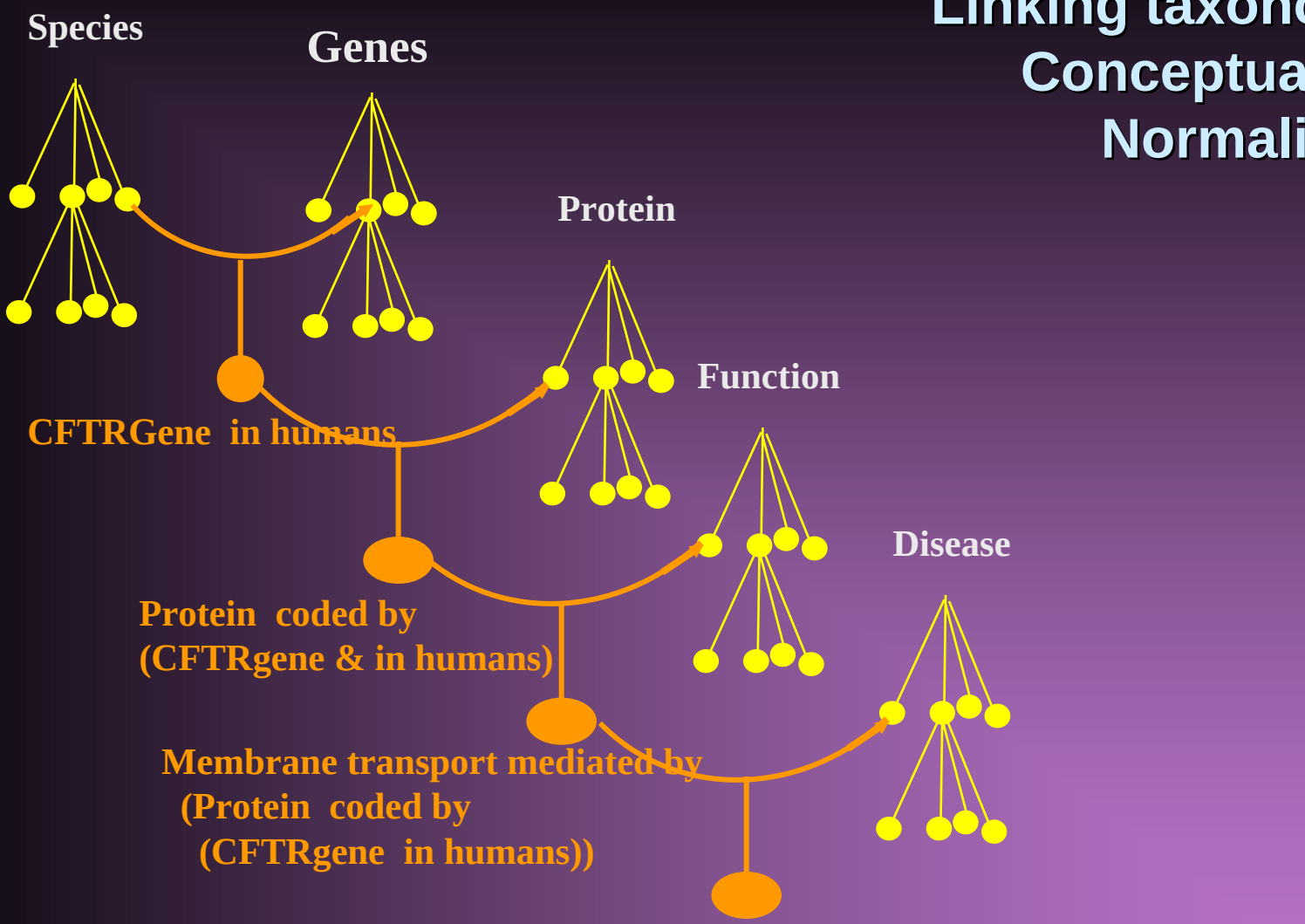
bacterial

Logic-based Ontologies: Conceptual Lego

"SNPolymorphism of CFTRGene causing Defect in MembraneTransport of ChlorideIon causing Increase in Viscosity of Mucus in CysticFibrosis…"

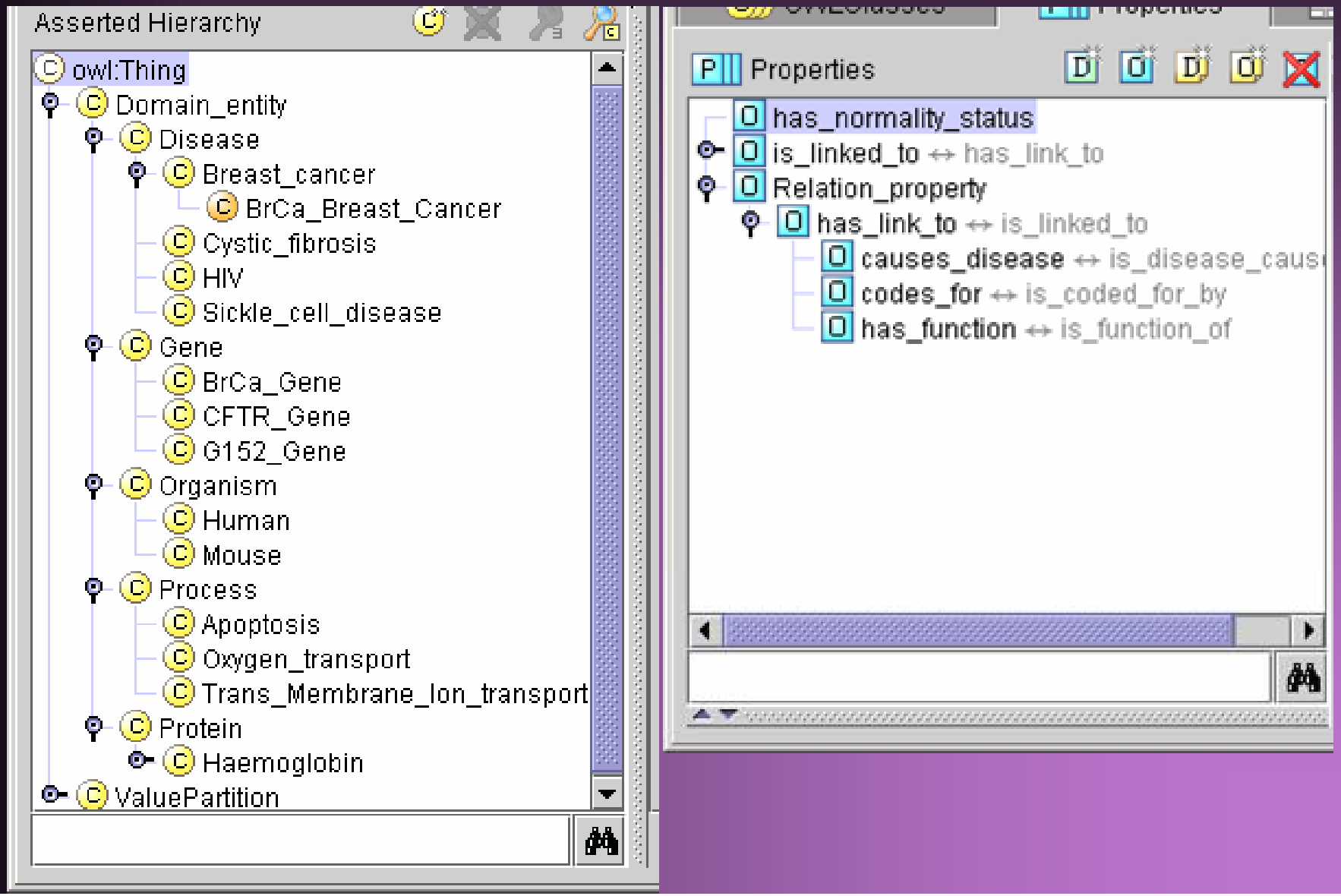
"Hand which is anatomically normal"

Linking taxonomies: Conceptual Lego Normalisation

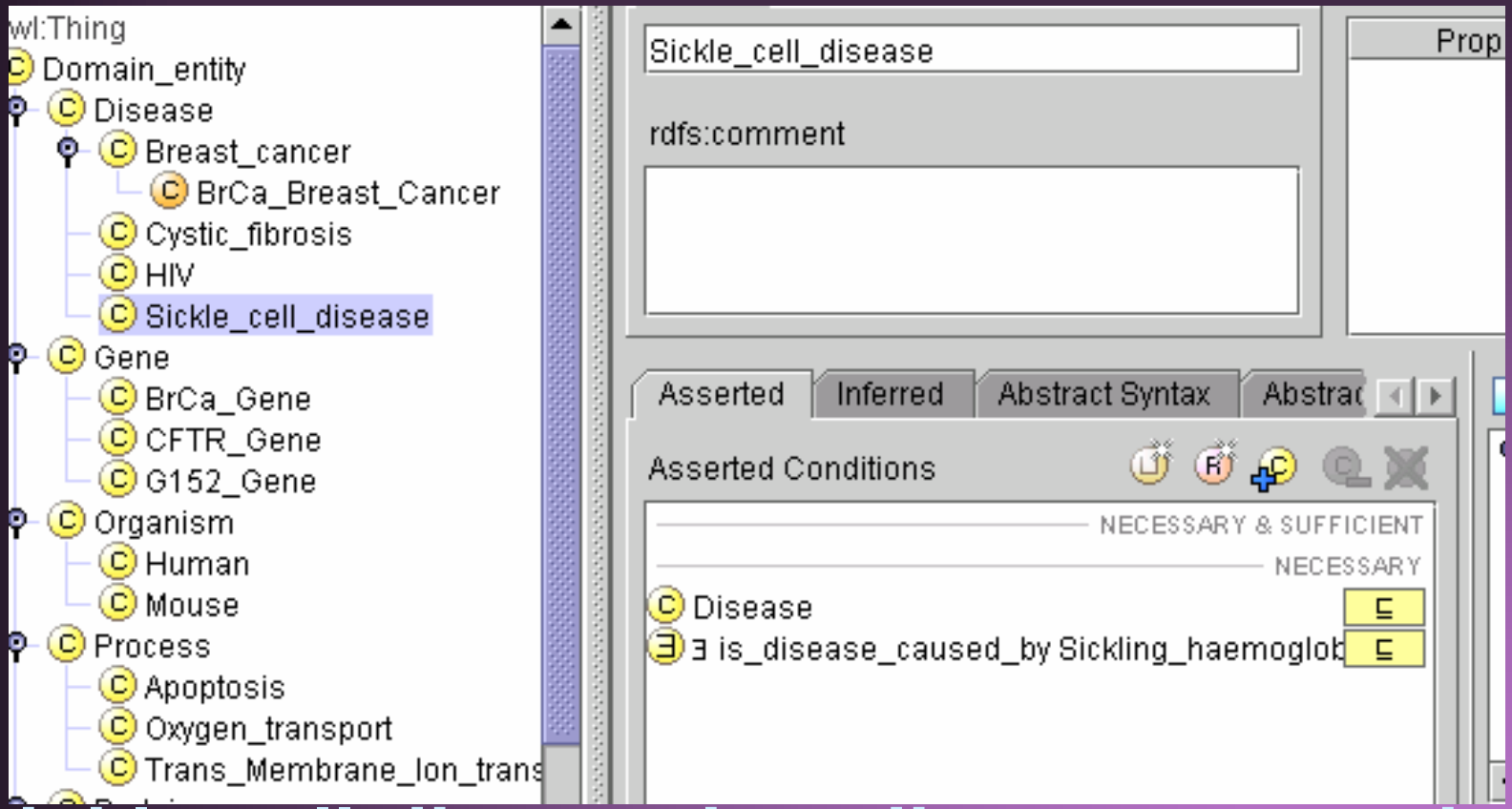


Conceptual Lego and Normalisation Practical Example

Take a Few Simple Concepts & Properties

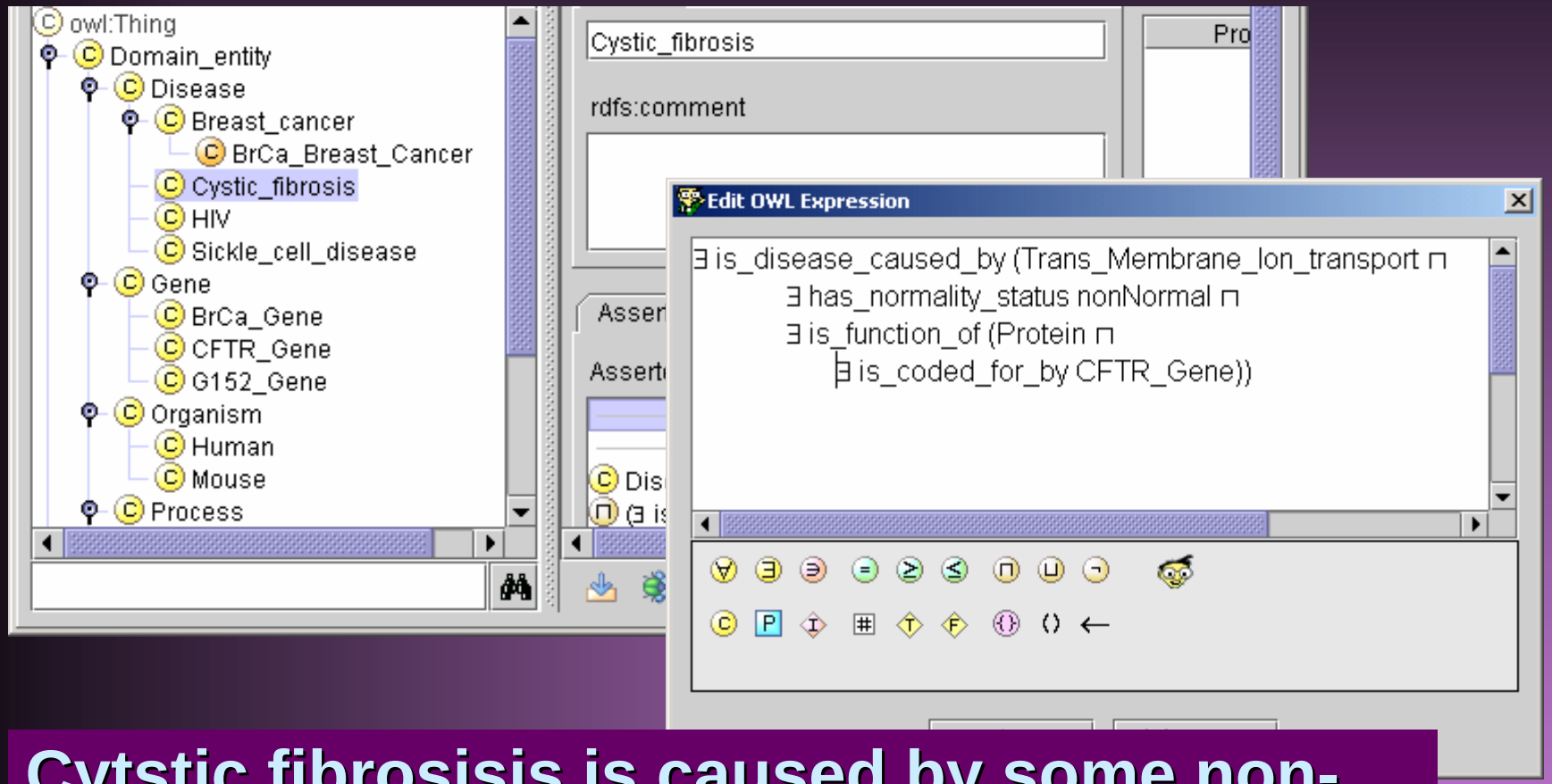


Combine them in Descriptions which can be simple….



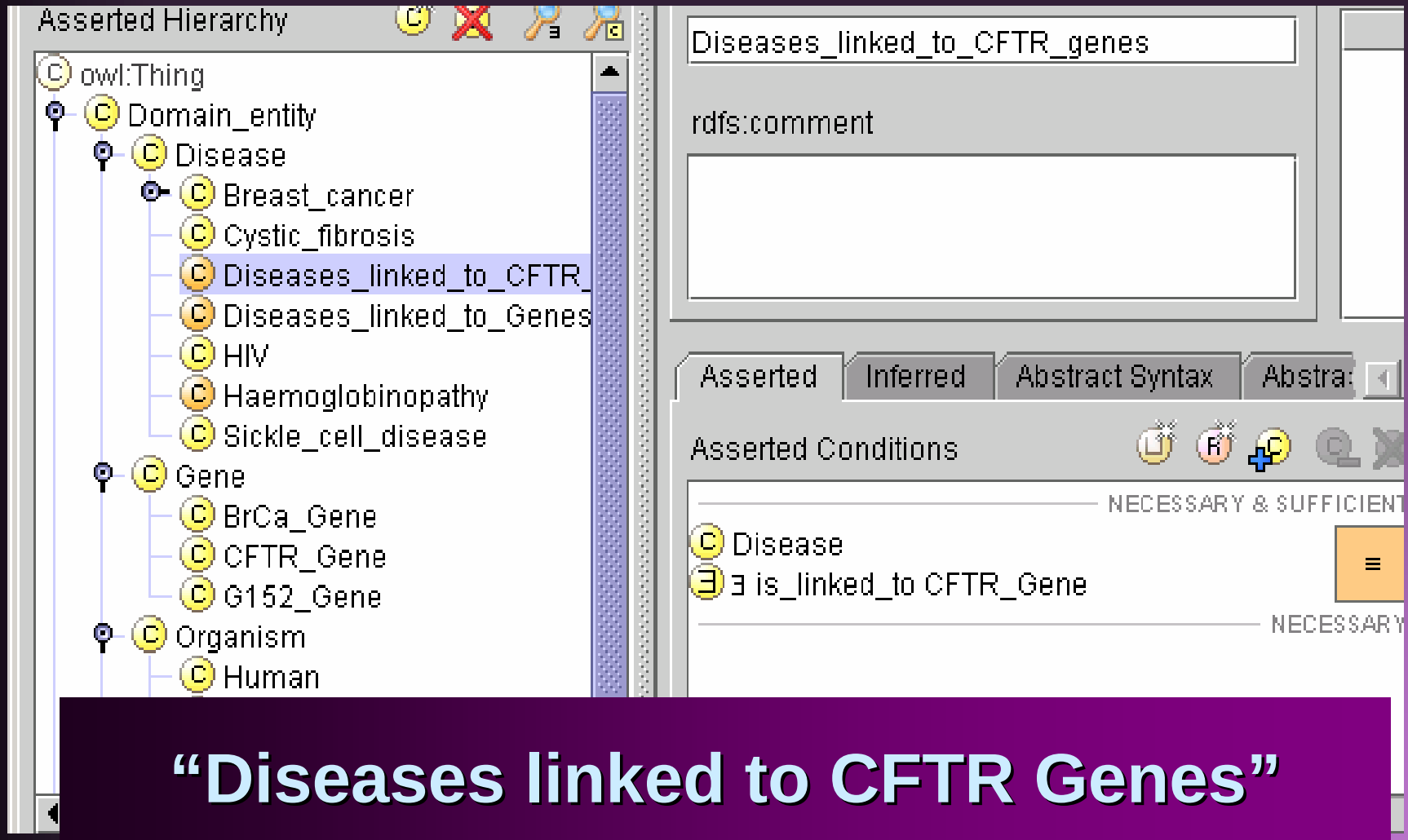
Sickle cell disease is a disease caused *some* sickling haemoglobin

or which can be as complex as you like



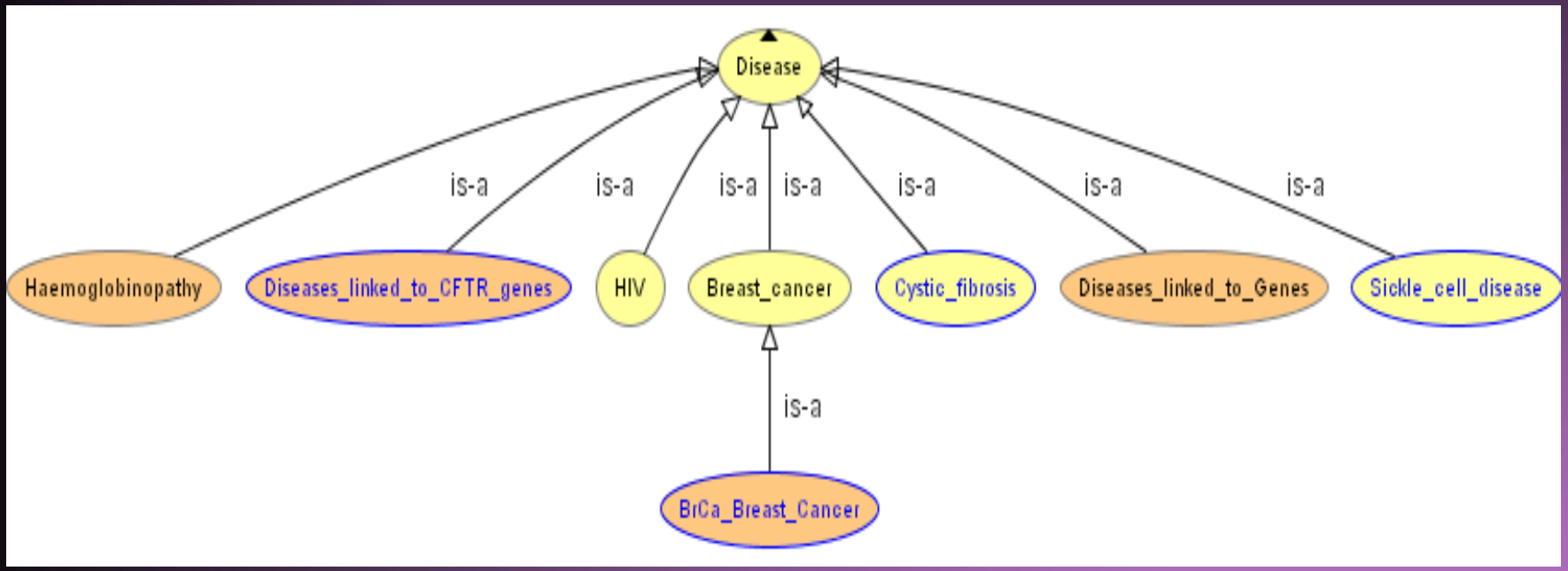
Cytstic fibrosisis is caused by some non-normal ion transport that is the function of a protein coded for by a CFTR gene

Add some definitions



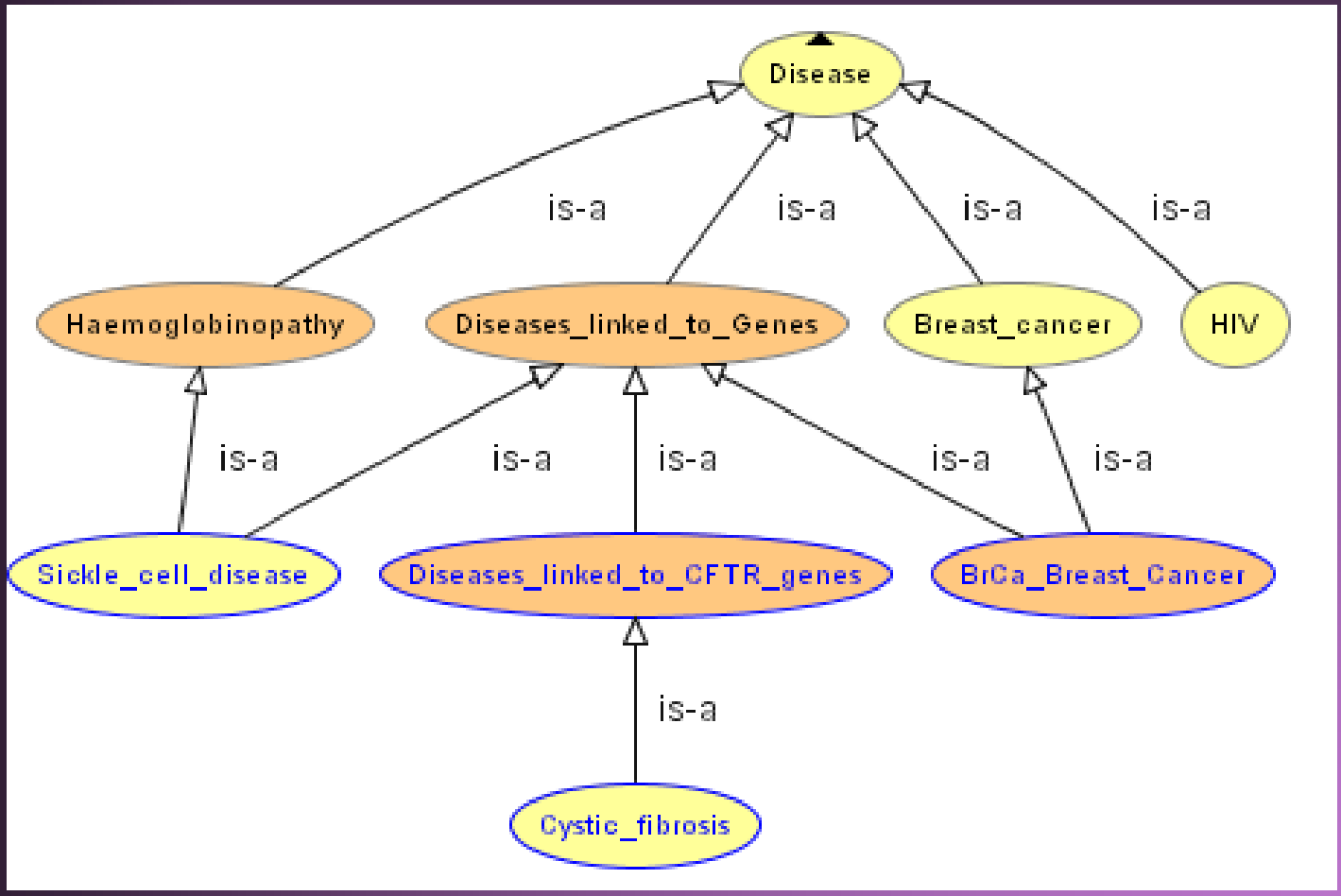
"Diseases linked to CFTR Genes"

We have built a simple tree

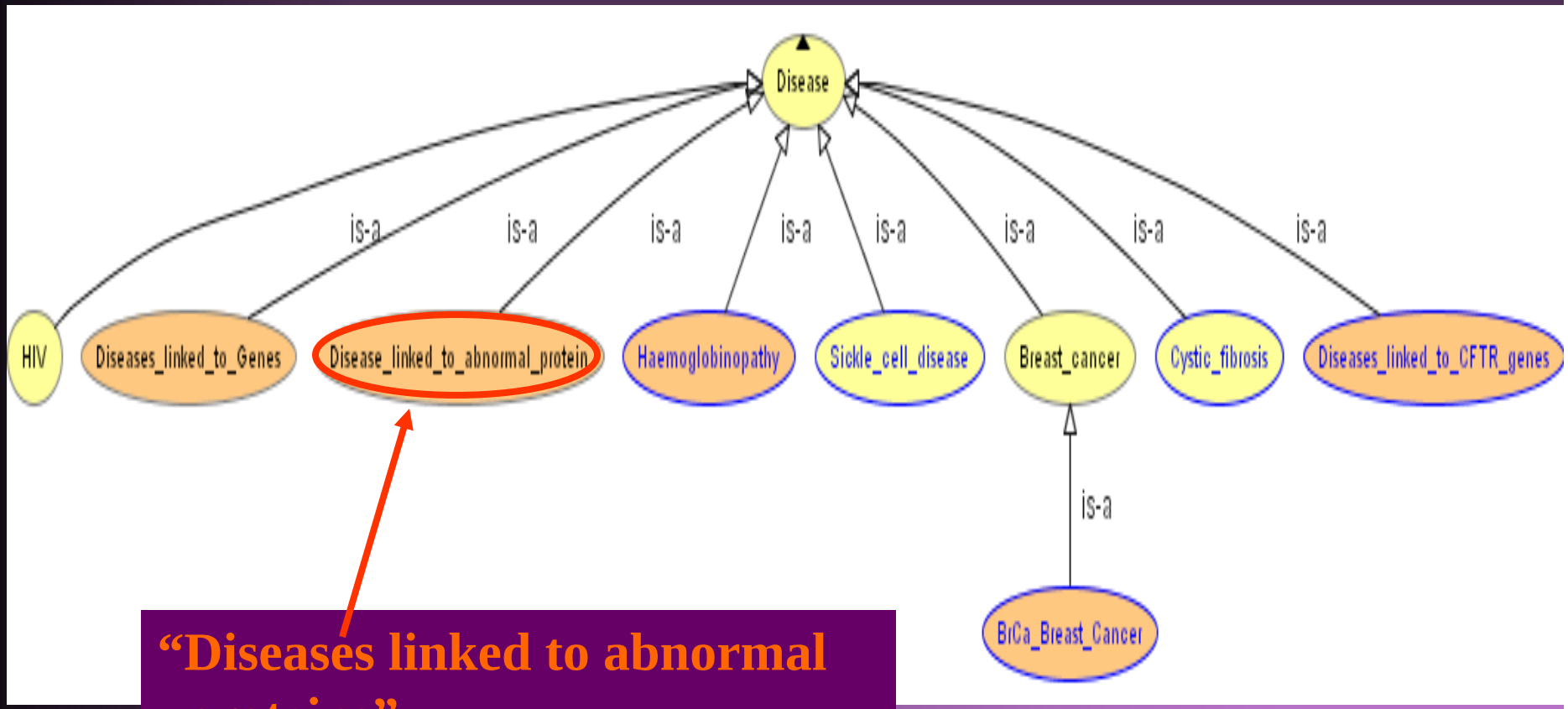


easy to maintain

Let the classifier organise it

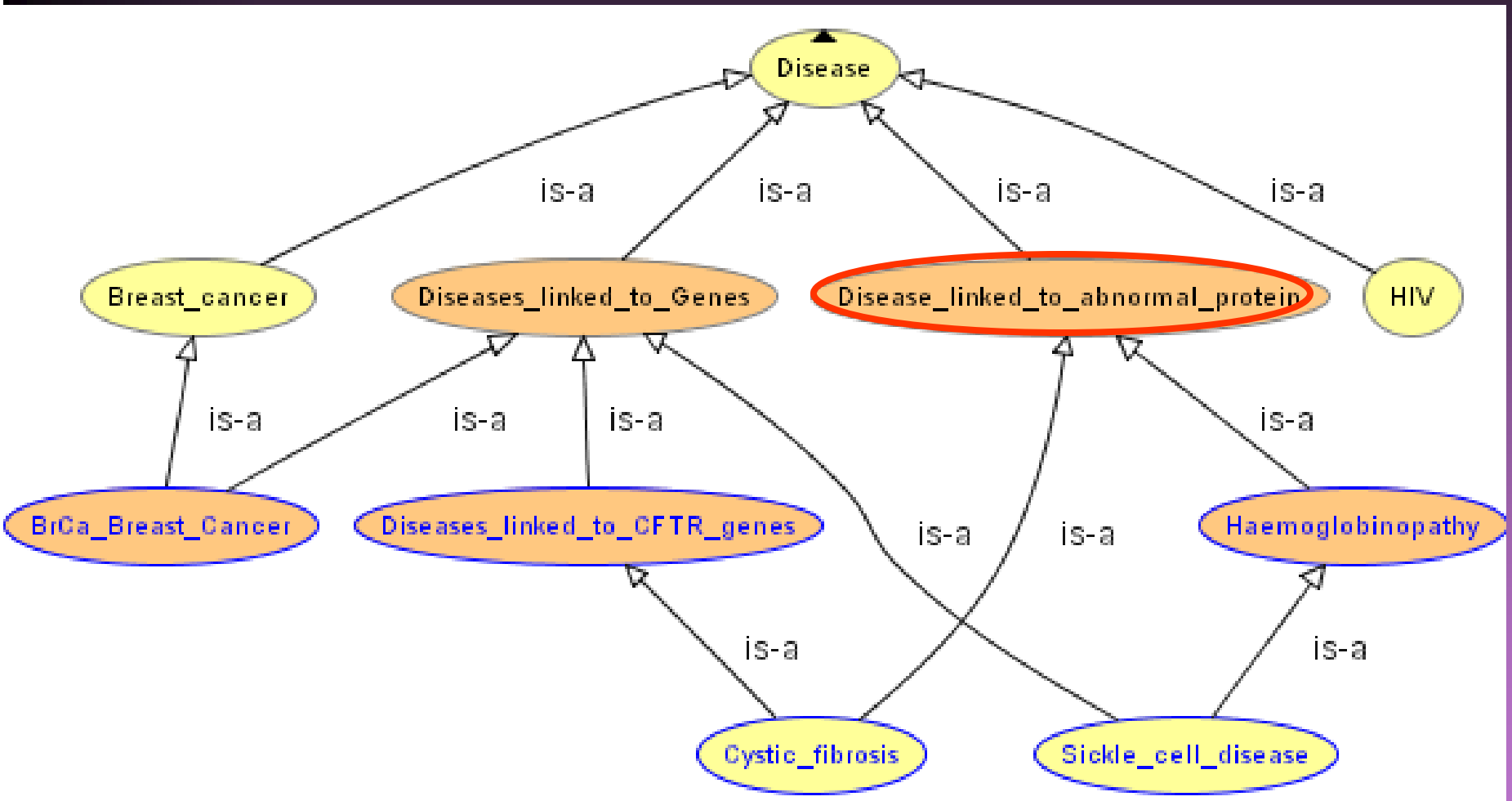


If you want more abstractions, just add new definitions
(re-use existing data)

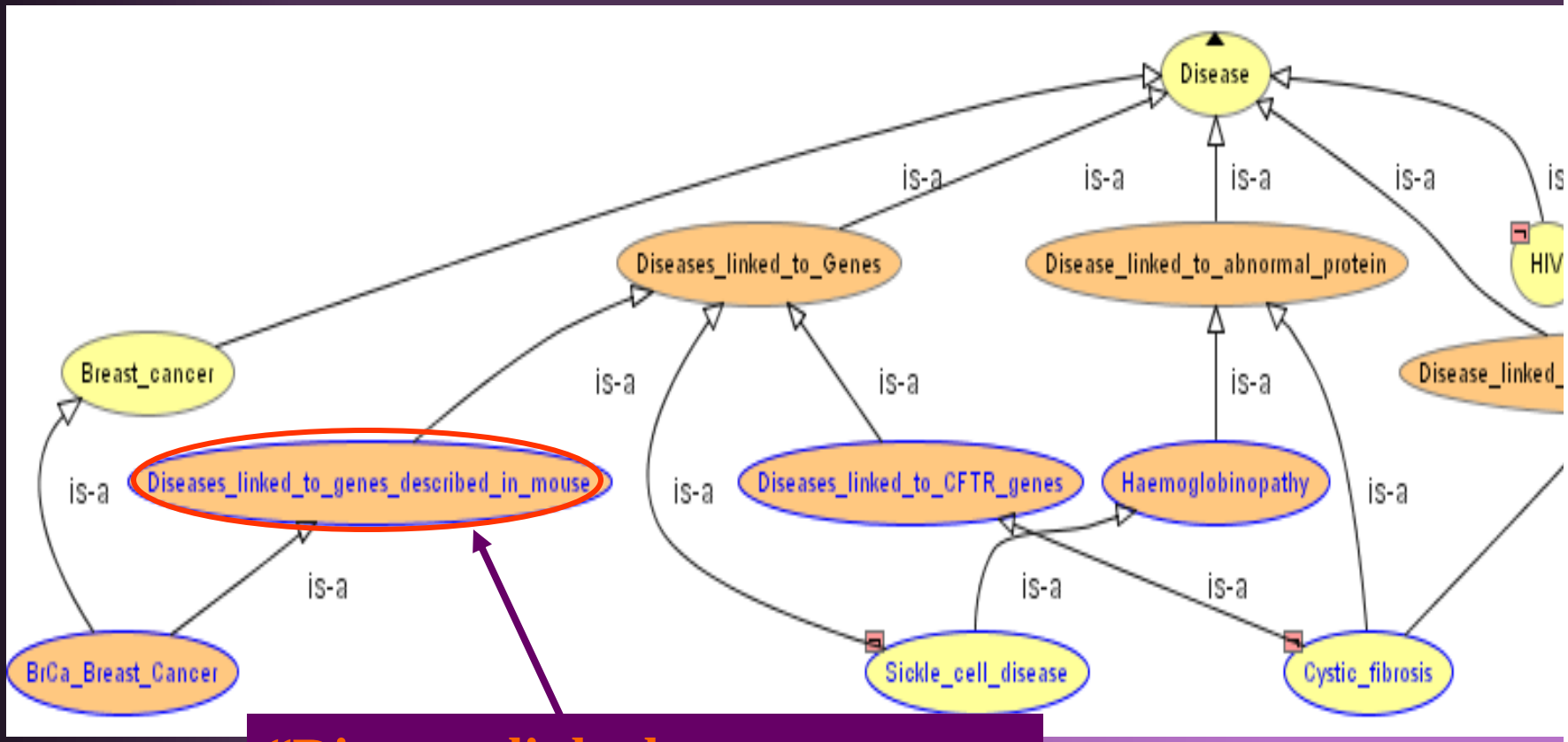


"Diseases linked to abnormal proteins"

And let the classifier work again

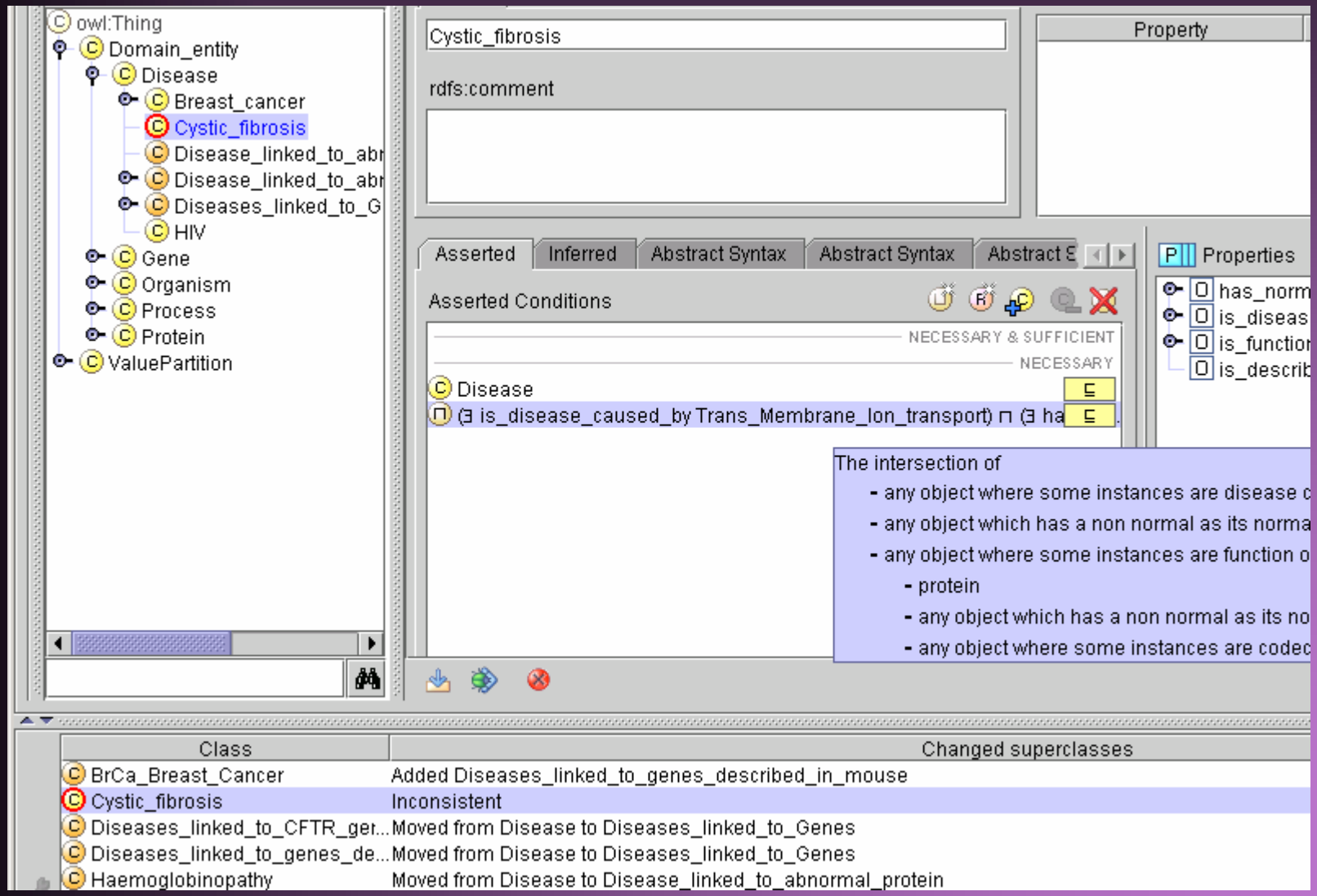


And again –
For a view based on species

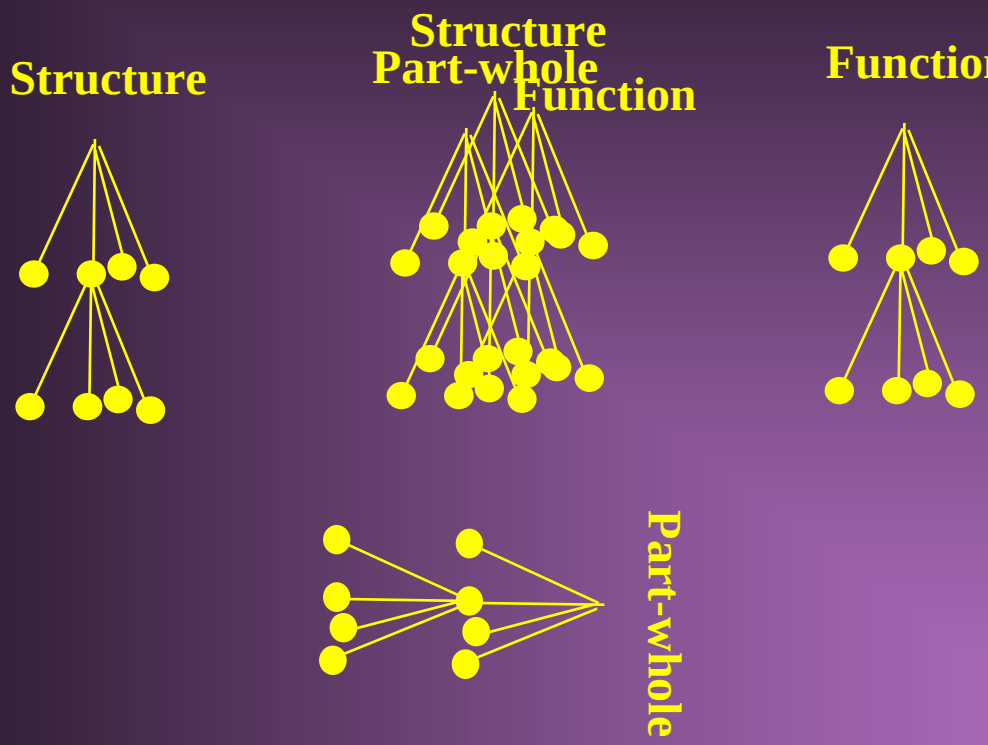


"Diseases linked genes described in the mouse"

And let classifier check consistency
(My first try wasn't)



Normalising (untangling) Ontologies



Untangling and Enrichment

Using a classifier to make life easier

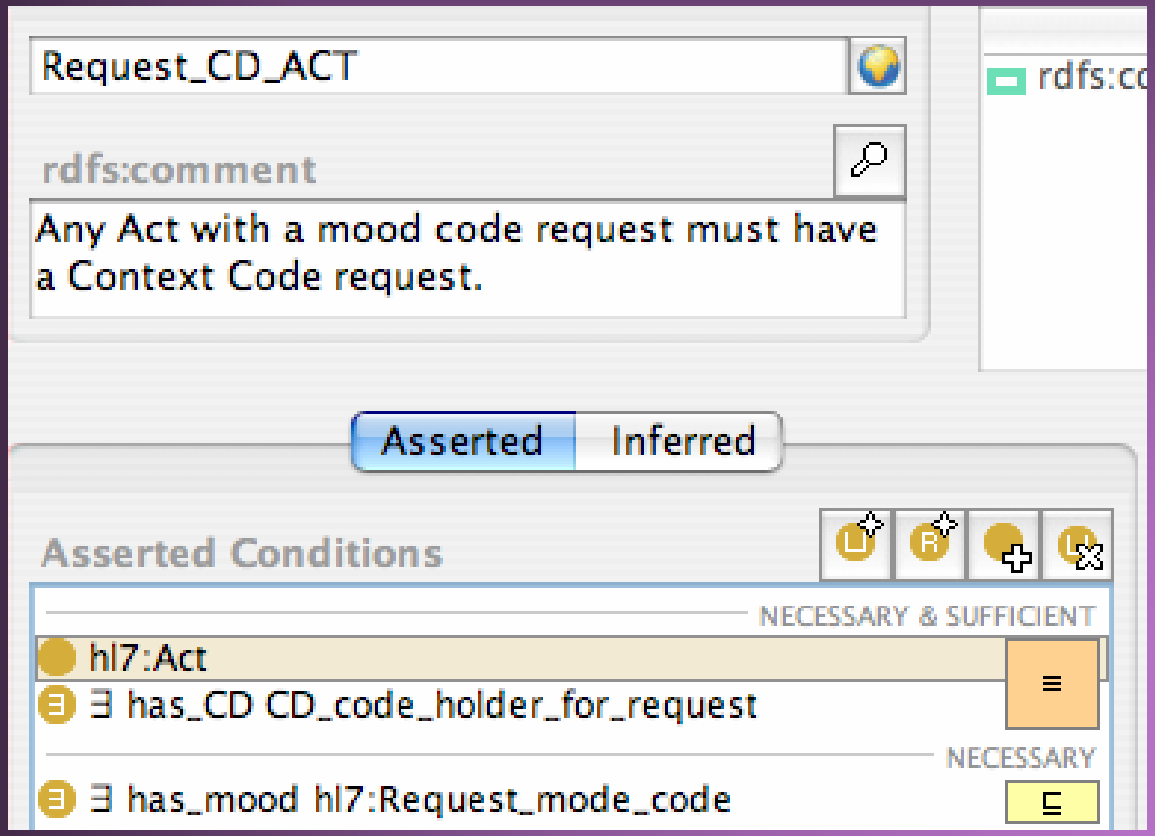
Substance
- Protein
- - ProteinHormone
- - - Insulin
- - Enzyme
- - - ATPase
- Steroid
- - SteroidHomone^
- - - Cortisol
-Hormone
- - ProteinHormone^
- - - Insulin^
- - SteroidHormone^
- - - Cortisol^
- Catalyst
- - Enzyme^
- - - ATPase^

Normalisation & Quality Assurance

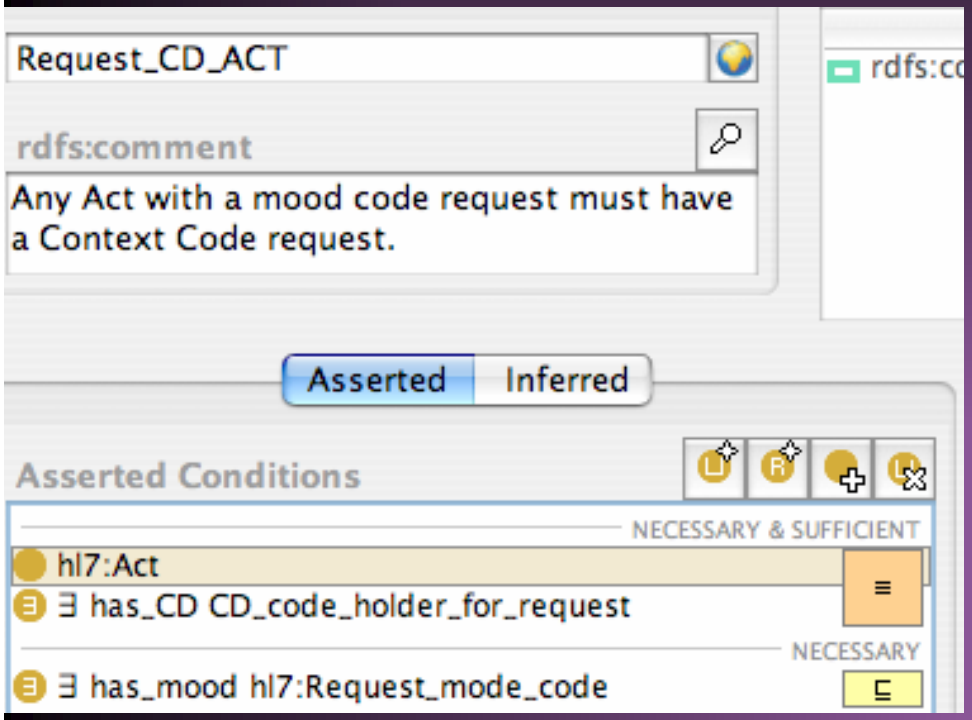
- **Humans recognise errors of commision easily**
  - **Miss errors of omission**
- **Classifiers convert errors of omission to errors of commission**
  - **Inadequate definitions create “orphans”**
    - **BodyPart**
      Parts of Heart
      Ventricle
      …
      CardiacSeptum
- **Classifiers flag errors of commision**
  - **Over definition leads to inconsistency (unsatisfiability)**
    - **“Pneumonia located in the brain”**

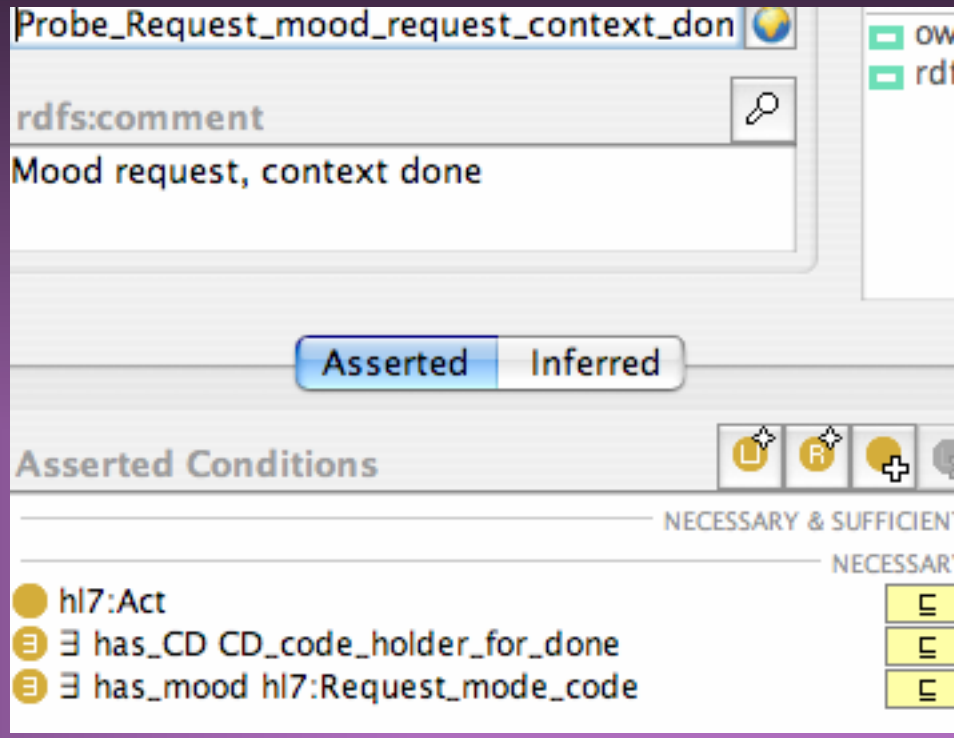
Enforcing constraints & policies

- A class with both necessary & sufficient and additional necessary conditions acts as a rule
- The Unit testing Framework supports checking that rules are enforced



A Probe class to check a constraint

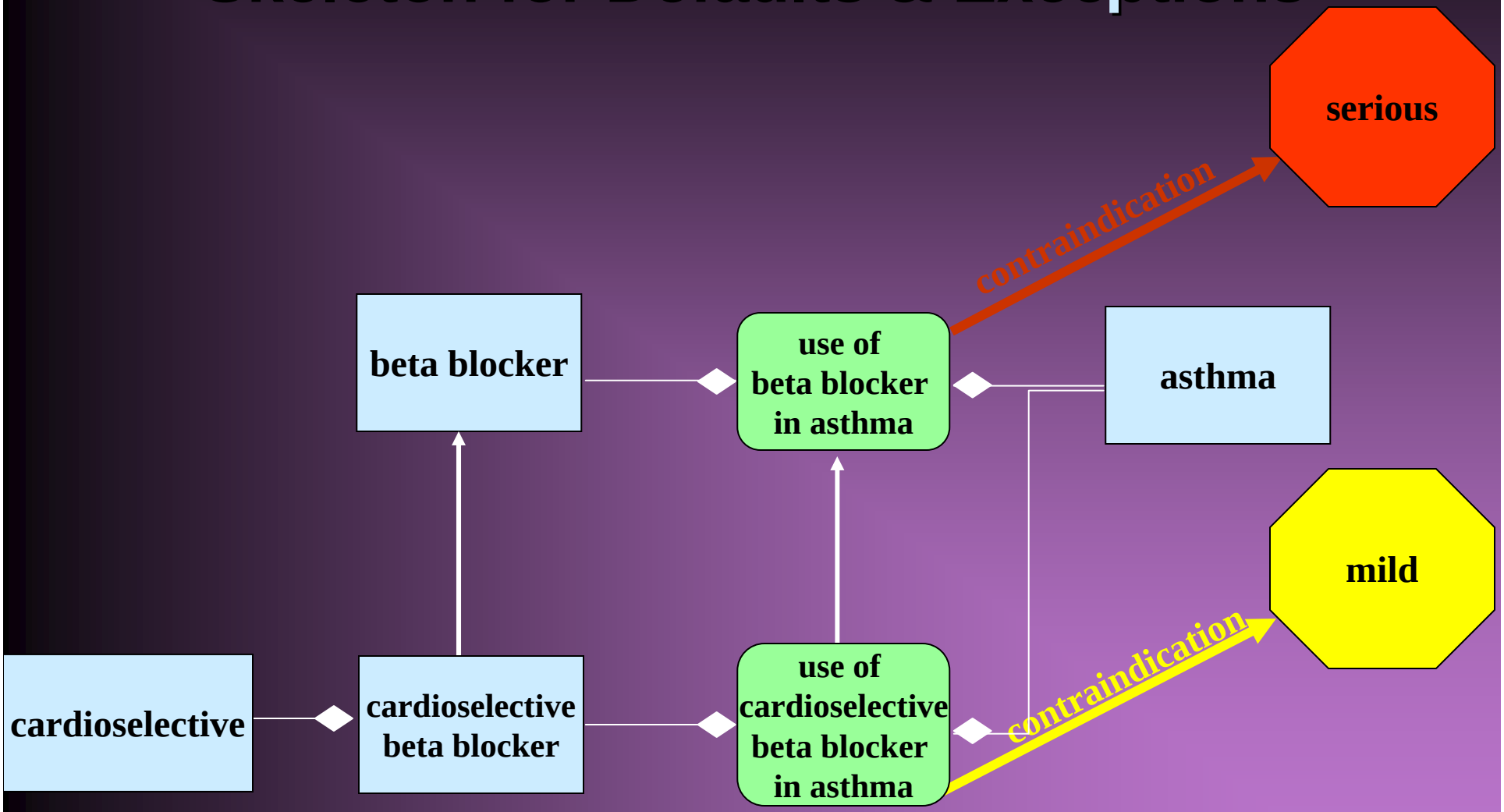




All Tests Passed

Type	Source	Test Result
✓	Probe_Request_mood_request_context_done	Expected consistecy (inconsistent) achieved
✓	Probe_Act_context_request_mode_event	Expected consistecy (inconsistent) achieved

Skeleton for Defaults & Exceptions



Experience: Normalised ontologists lead to clean default inheritance

When to Classify

- … but isn't having a classifier an intollerable overhead for the applications?
  - It depends on the life cycle you choose
- Life cycles
  - Pre-coordination
  - Just in time coordination
  - Post Coordination

Pre-coordination

If the terms can be enumerated in advance

Authors

Asserted form "Sources"

Classifier "Compiler"

Classified form "binary"

("high level language"
"intermediate representations")

Application

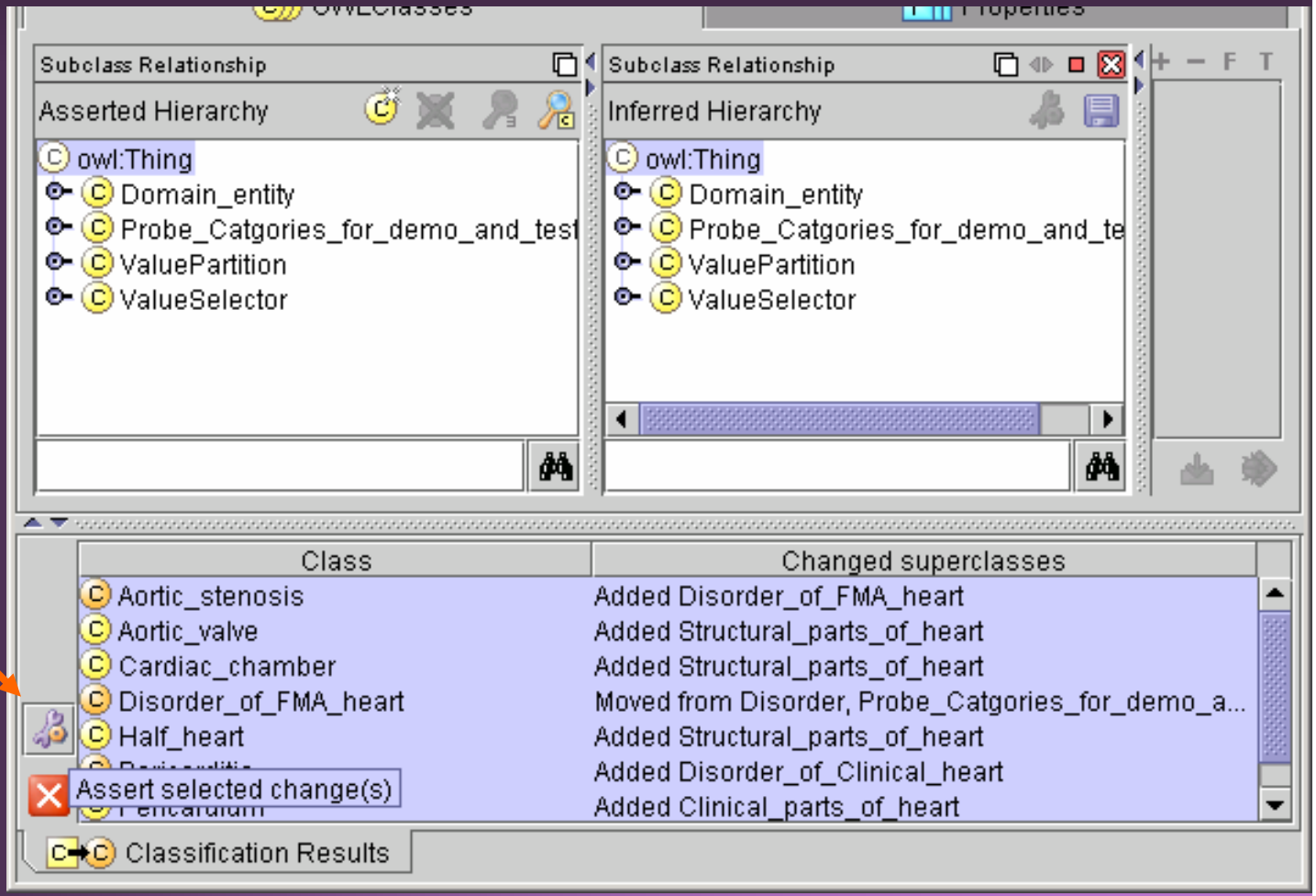
Users

Overwhelming the dominant pattern today.

"binary" can be
OWL Light RDF(S),
XML Schema, OBO, …

Commit Results to a Pre-Coordinated Ontology

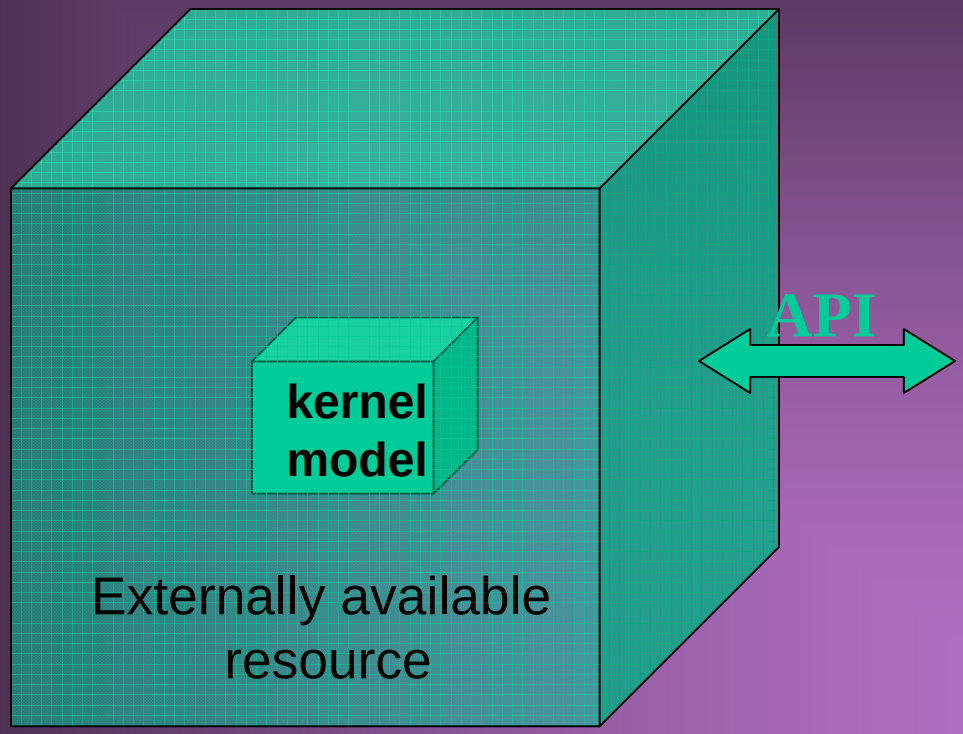
Assert ("Commit") changes inferred by classifier



Post coordination|

When there are combinatorially many potential terms

- **"Lazy classification" on demand**



Big on the outside: small kernel on the inside

Avoid the exploding bicycle

Post Coordination

Authors

Asserted form "Sources"

(& intermediate representations)

Asserted Ontology Store

Classifier "Compiler"

Terminology Services

Application

Users

But requires a classifier available at application time

A Compromise
Just in Time Coordination

Authors

Asserted form "Sources"

(& intermediate representations)

Asserted Ontology Store

Classifier "Compiler"

Pre-coordinated Cache

Terminology Services

Application

Users

Only the occasional new notion Requires classification -

need not be real time

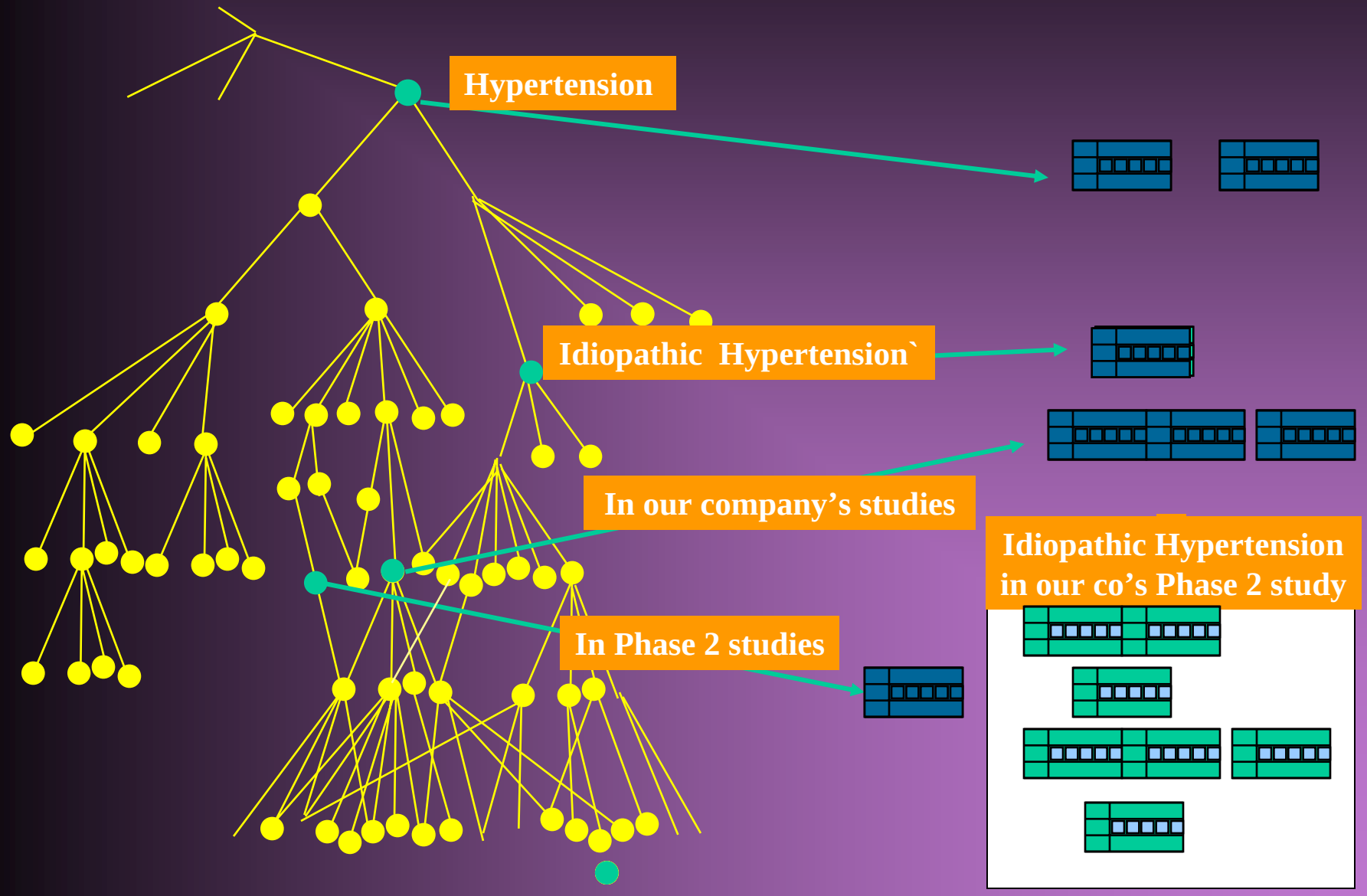
Summary

- **Why Classify**
  - **Managing Compositional ontologies / Terminologies**
    - **“Conceptual Lego”**
    - **Empowering users - just in time classification**
    - **Providing views & deferring decisions on abstractions**
    - **Quality assurance**
  - **Constraining concepts & schemas**
  - **Providing a skeleton for default reasoning & Prototypes**
- **When to classify**
  - **Pre-coordination**
  - **Just-in-time coordination**
  - **Post-coordination**

Summary: When to Classify?
Applications do not need a classifier to benefit from classification

- **Pre-coordination**
  - **If concepts/terms can be predicted**
  - **When classifier is not available at run time**
  - **When we must fit with legacy applications**
- **Post-coordination**
  - **When a a few concepts are needed from a large potential set**
  - **When a classifier is available**
    - **and time cost is acceptable**
  - **When applications can be built or adapted to take advantage**

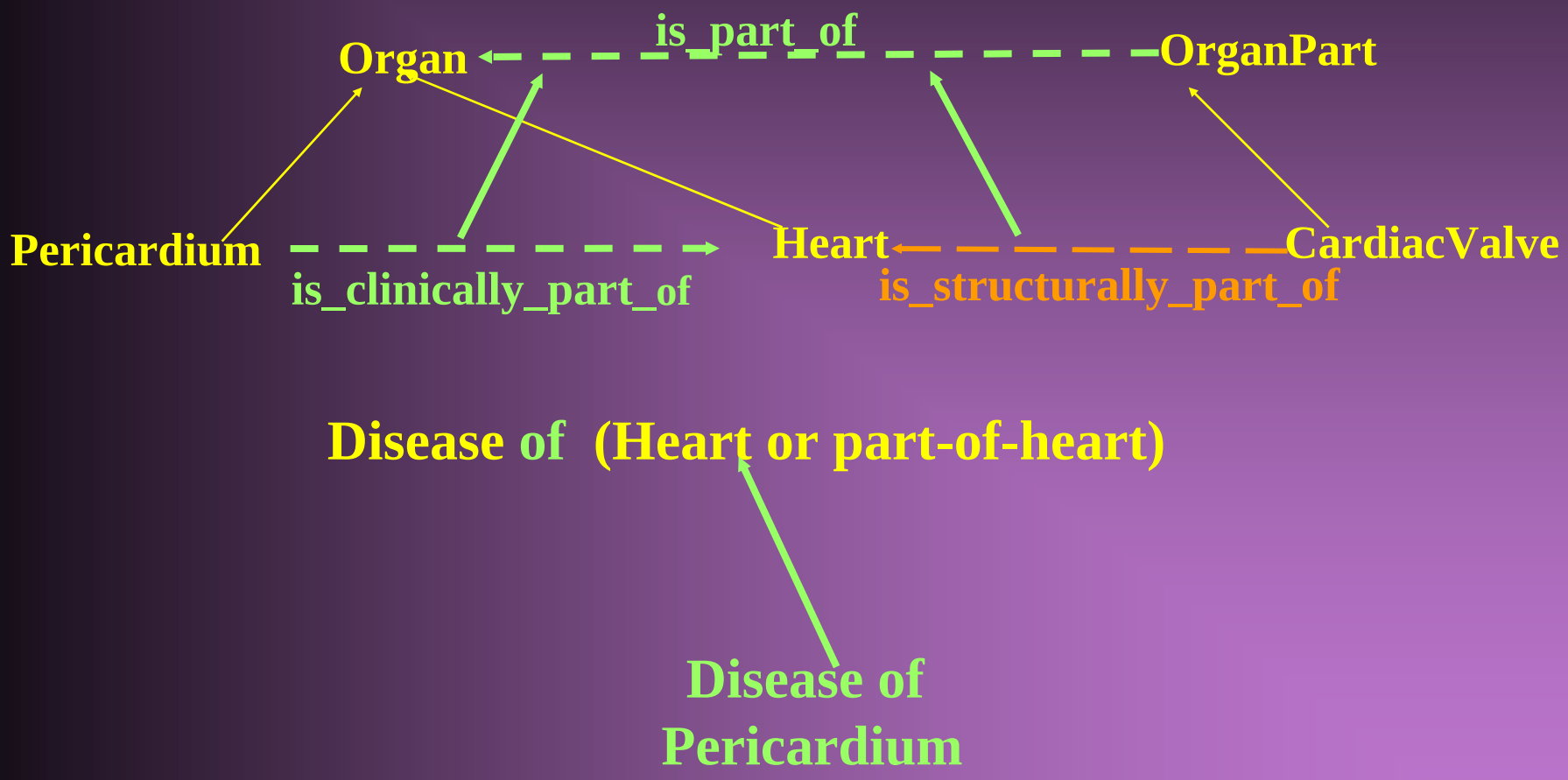
Skeleton for Fractal tailoring forms for clinical trials



More on Views

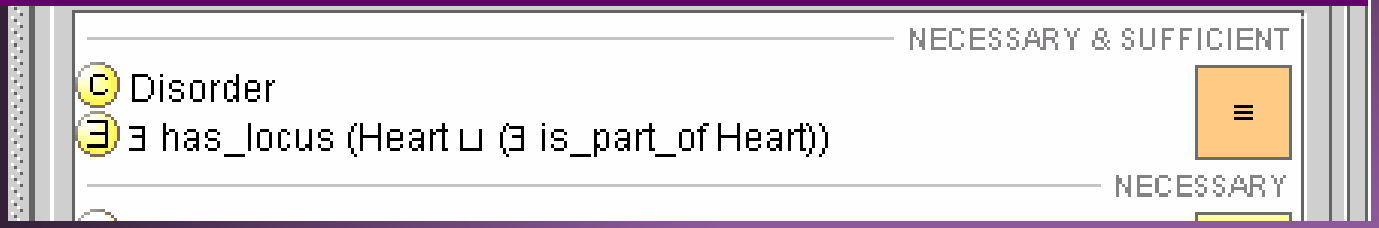
- A problem in the digital anatomist
  - To an anatomist, the Pericardium and the Heart are separate organs
  - To a clinician they are part of the same organ
    - A disease of the pericardium counts as a kind of heart disease

Represent context and views by variant properties



Protégé-OWL alternative views

Disorder of “Clinical heart”
“Disorder of heart of any part of the heart”
(including *clinical* and *functional* parts)



Disorder of “FMA heart”
“Disorder of heart or any *structural* part of the heart”