Japan Medical Ontology Development Project for Advanced Clinical Information Systems

Takeshi IMAI [1) 2)], Hiroko KOU [3)], Jun ZHOU [3)],
Kouji KOZAKI [3)], Riichiro MIZOGUCHI [3)] and Kazuhiko OHE [1)]

1) The University of Tokyo Hospital
2) Mayo Clinic
3) Osaka University, The Institute of Scientific and Industrial Research (ISIR)

The outline of this presentation

- (1) Introduction
- (2) Important features of our description framework:
  - Class constraint, Role, and Role holders
  - ‘p-’ operator
- (3) Definition of anatomical entities
  - Upper level structure
  - Defining common properties among organs
- (4) Definition of diseases
  - Definition of diseases as a set of ‘abnormal states’
  - Representation of the etiological chain
  - On-demand reorganization of hierarchical tree
- (5) Concluding Remarks

Introduction (1)
-Background -

- **[Background]:**
  - The spread of electronic medical records (EMRs)
    → Increase of the medical care information being compiled electronically using Natural Language
  - Natural Language Processing (NLP)
    → one of the key techniques for processing clinical text databases

  In addition to NLP:
  It is highly desirable to develop a new technology / knowledge base for **semantic information processing** to achieve advanced intellectual information system

- **[Medical Ontology]:**
  - One of the fundamental techniques/knowledge bases for…
    (1) Advanced clinical text processing
    (2) Semantic interoperability among various domains and tasks
    (3) Machine reasoning systems
    (4) Education
    … and so on.

Introduction (2)
- Why Japanese Medical Ontology ? -

- Substantial efforts have been made to build Medical Ontologies so far …
  - GALEN, FMA, SNOMED-CT,…
- **(BUT):**
  - Japanese medical terms are not included in it
  - A simple translation would hide some possible concepts specific to Japanese clinical practice

  * The region of **"Back"**
  * The definition of **"Early Stomach Cancer"**
  * The definition of **"Acute"**
  * …., etc.

Different diagnostic criteria of 'Cancer'

[JP]: the grade of cellular atypia
[US]: structural atypia

- **(Our strategy):**

  1st step)
  To develop Japanese medical ontology which reflects Japanese clinical concepts

  2nd step)
  To create mappings between our ontology and the existing ones

Introduction (3)

- Japanese Medical Ontology Development Project -

- The Japanese [illegible] of Health, Labor, and Welfare has laun[illegible] Da[illegible]

[Go[illegible]

[illegible]ely

* 3,000 procedures

and so on.

- The current existing medical ontologies differ according to each one's ontological model and level of development
- Some of them are incomplete in terms of ontological theories.
  (Schulz et.al '07 "SNOMED-CT's problem list", etc.)

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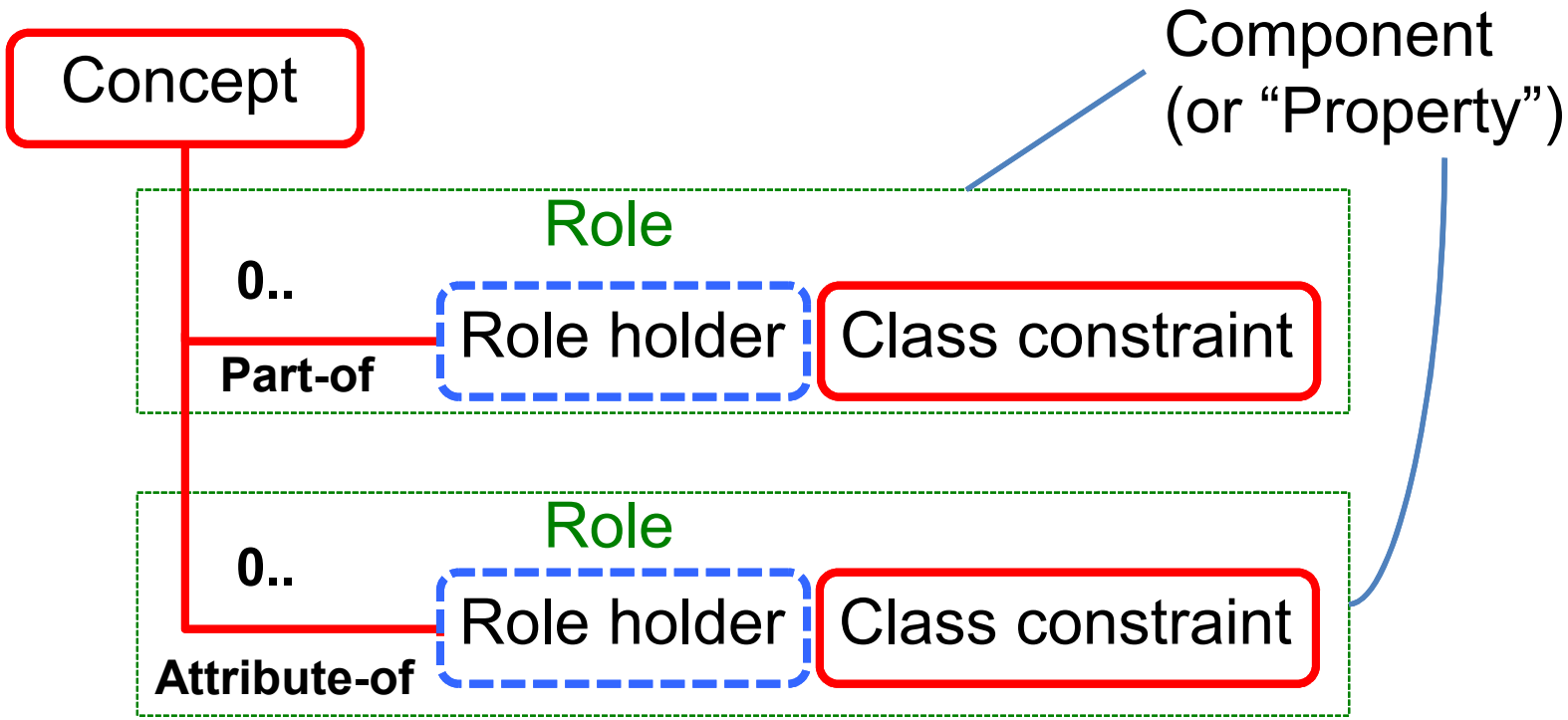
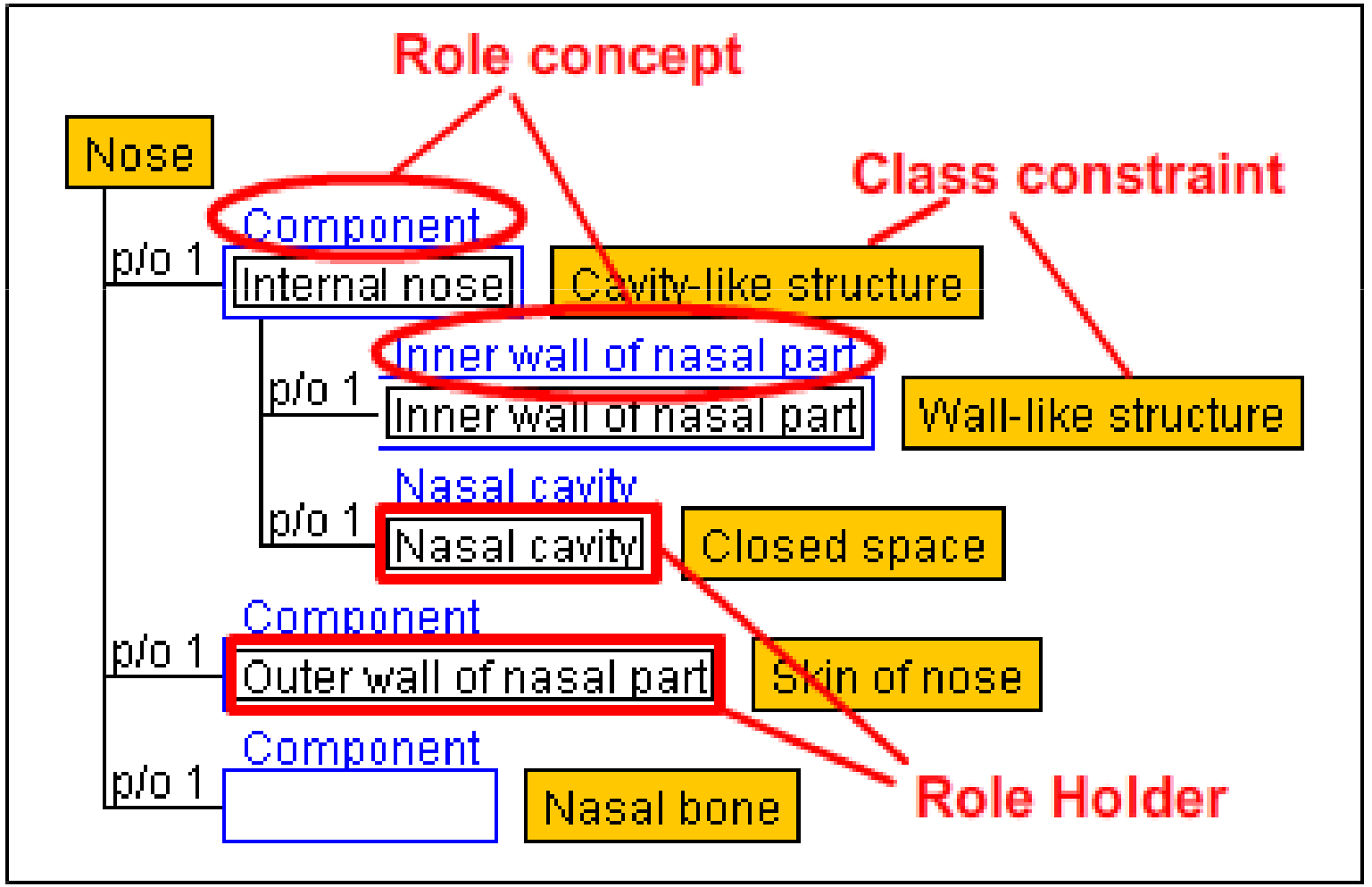
Class constraint, role, and role holder

- [Basic description framework for a concept]

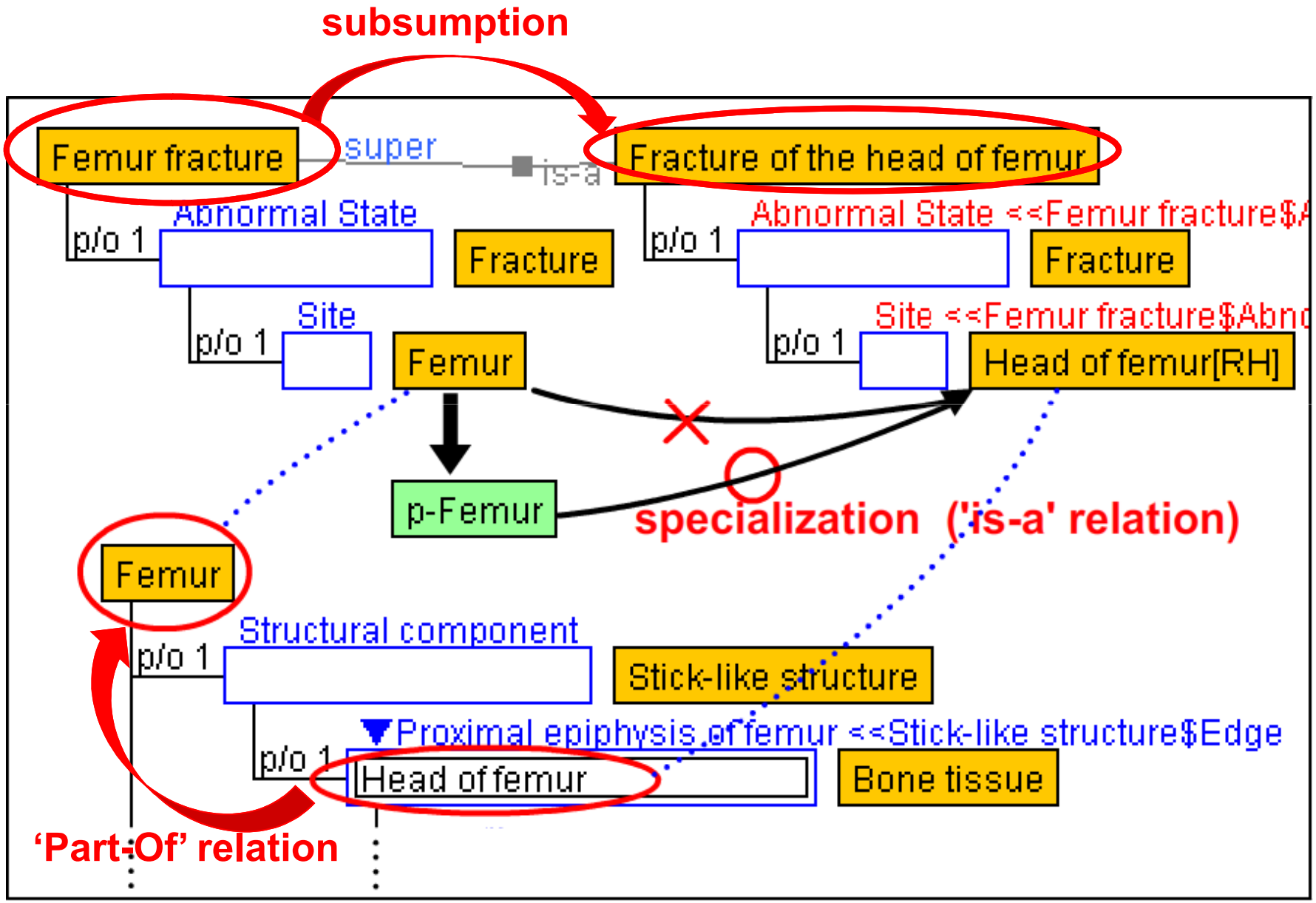


Class constraint, role, and role holder

- (ex) the definition of “Nose”

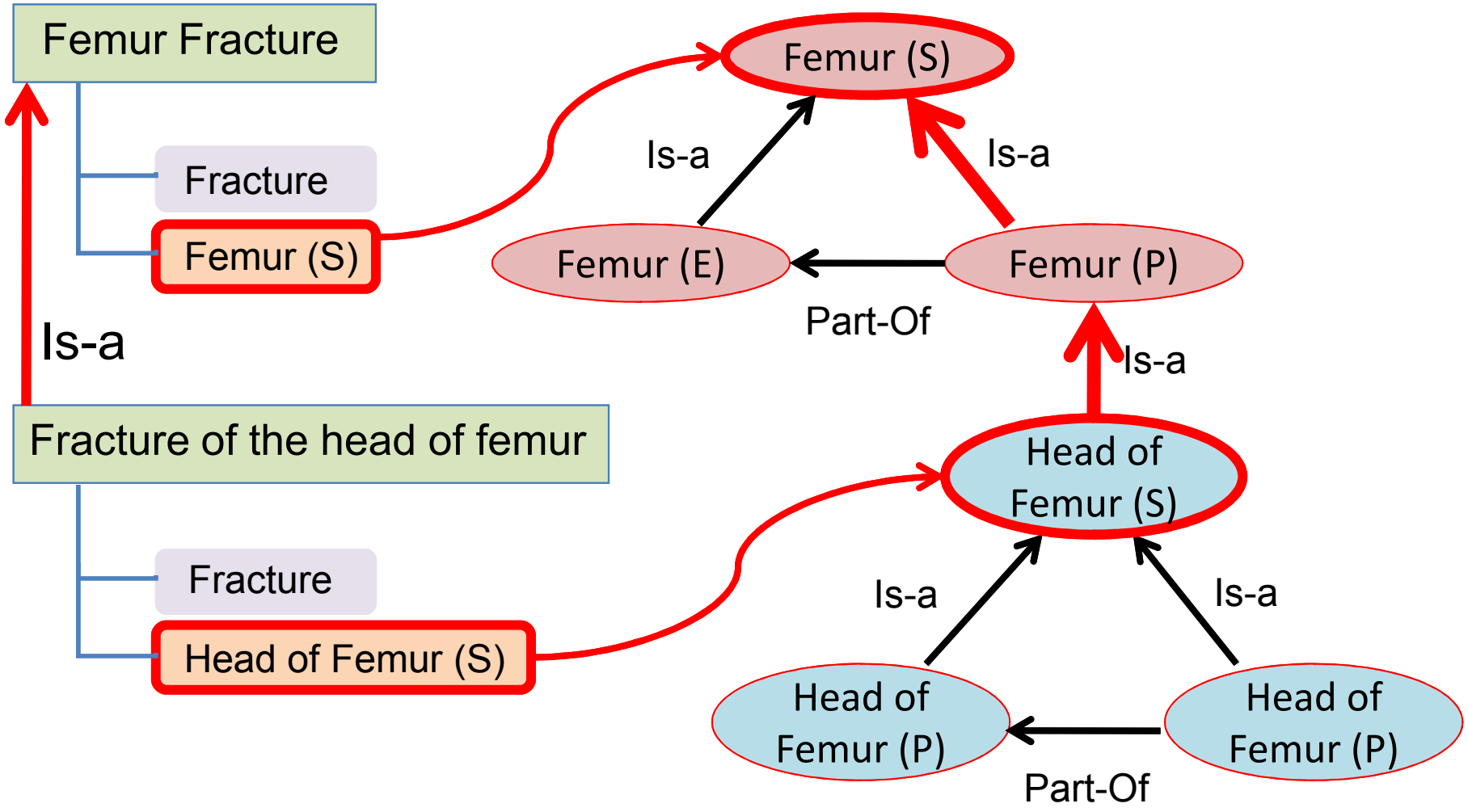


‘p-’ operator (1)

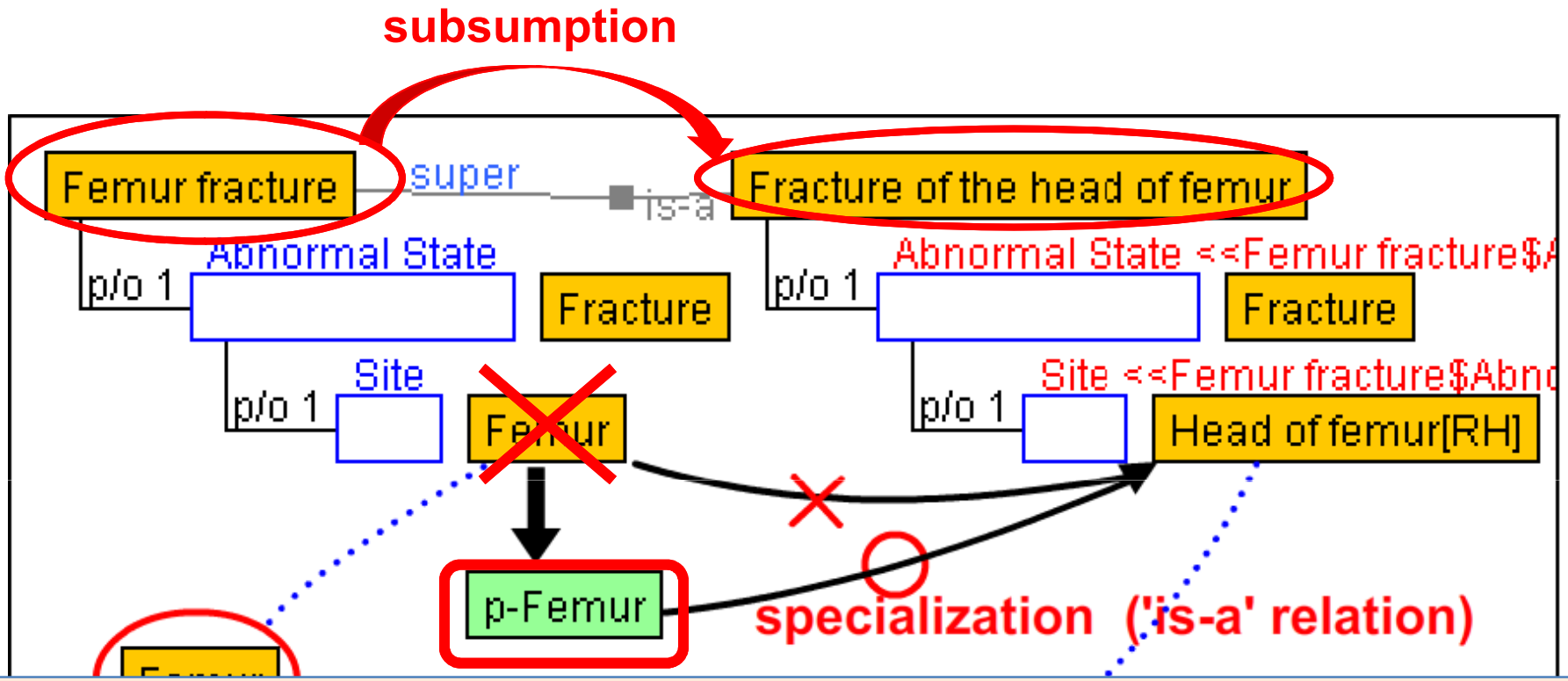

subsumption
Femur fracture
super
is-a
Fracture of the head of femur
Abnormal State
p/o 1
Fracture
Abnormal State <<Femur fracture$A
p/o 1
Fracture
Site
p/o 1
Femur
Site <<Femur fracture$Abnc
p/o 1
Head of femur[RH]
p-Femur
specialization ('is-a' relation)
Femur
Structural component
p/o 1
Stick-like structure
Proximal epiphysis of femur <<Stick-like structure$Edge
p/o 1
Head of femur
Bone tissue
‘Part-Of’ relation

(cf) SEP-triplet

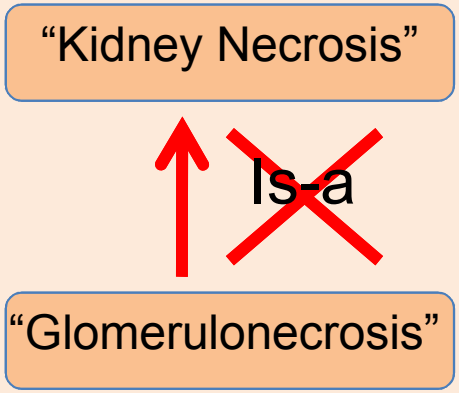
- One famous solution is '[SEP-triplet]' by Schulz and Hahn ('05)



‘p-’ operator (2)



[NOTE]:



In this case, we should NOT use ‘P-’ operator for “Kidney”

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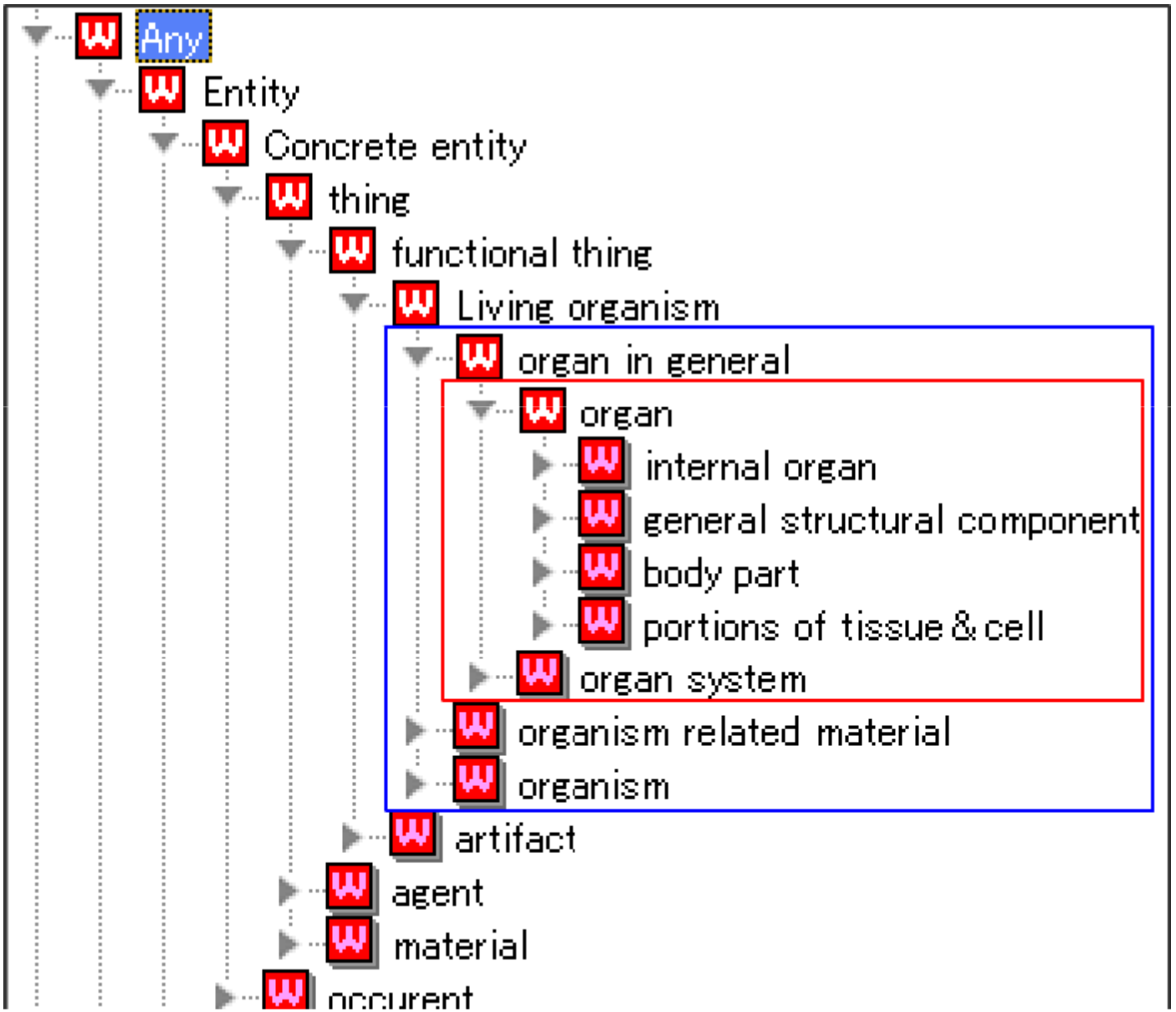
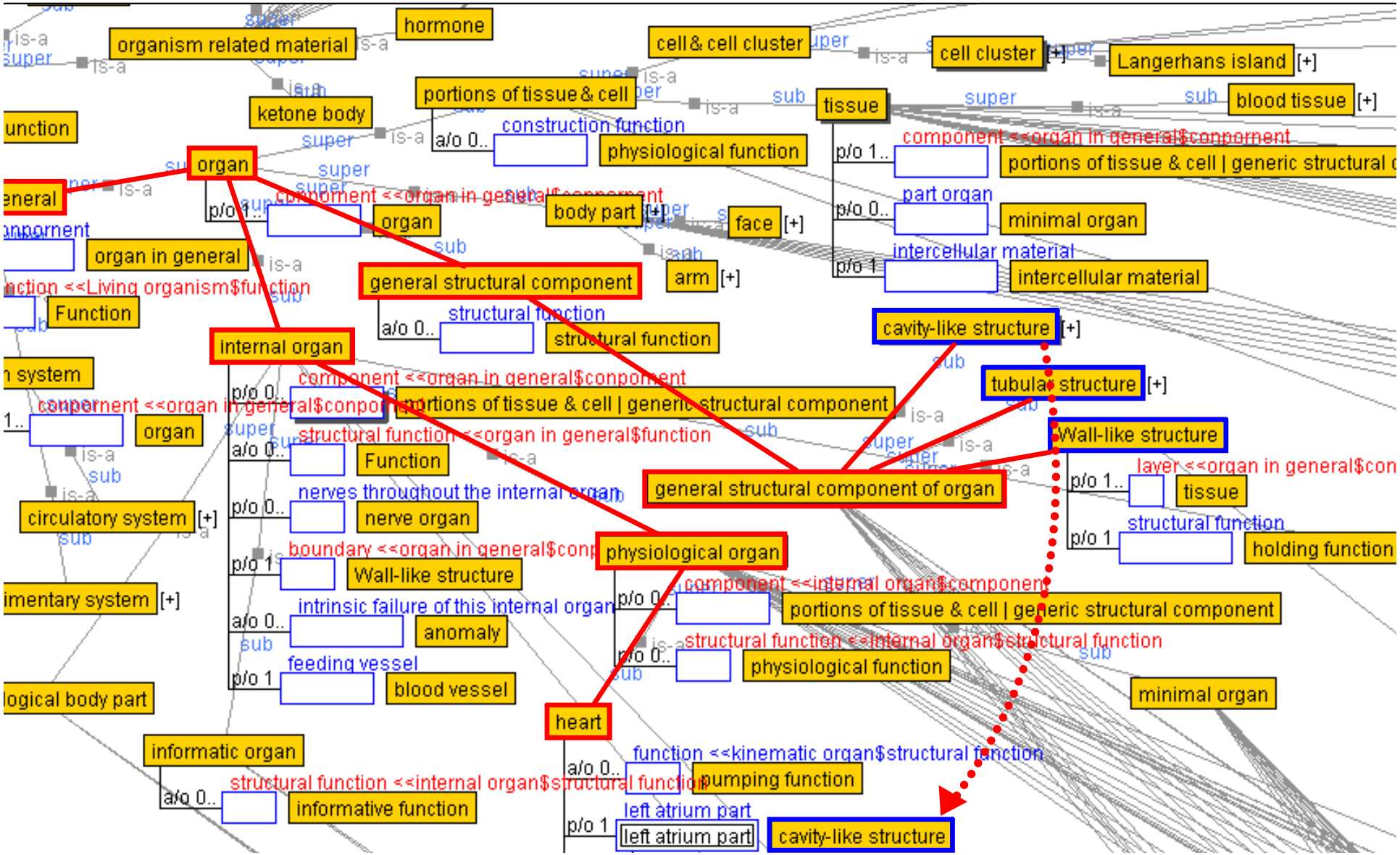
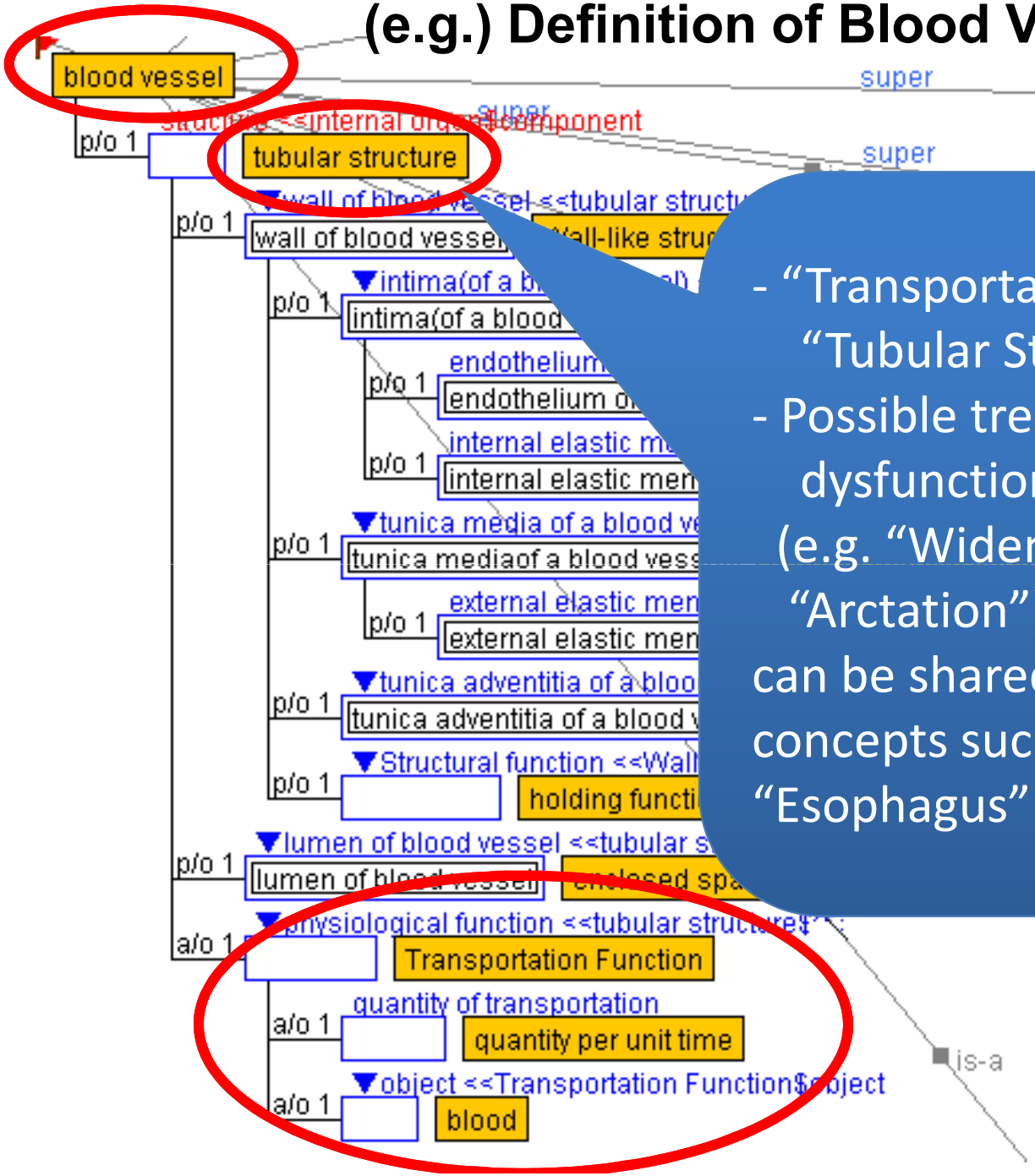
Upper structure of anatomical entities



Defining "common properties among organs" using "General Structural Components"



(e.g.) Definition of Blood Vessel



- "Transportation function" of "Tubular Structure"
- Possible treatments for the dysfunction (e.g. "Widening operation" for "Arctation")

can be shared among many concepts such as "Blood Vessel", "Esophagus"

Notes:

- “Basic concept class” or “Role holders” ?
  - “Heart”, “Cardiac muscle cell” → Basic concept
  - “Atrium”, “Cardiac muscle tissue” → Role holder

[Distinction criterion]
→ whether it is **context-free** or not.

- Comparison with FMA
  - No distinction between ‘Class restriction’, ‘Role’, and ‘Role holders’ in FMA
  - Instead of that, many virtual classes are introduced, which can lead to redundant expressions

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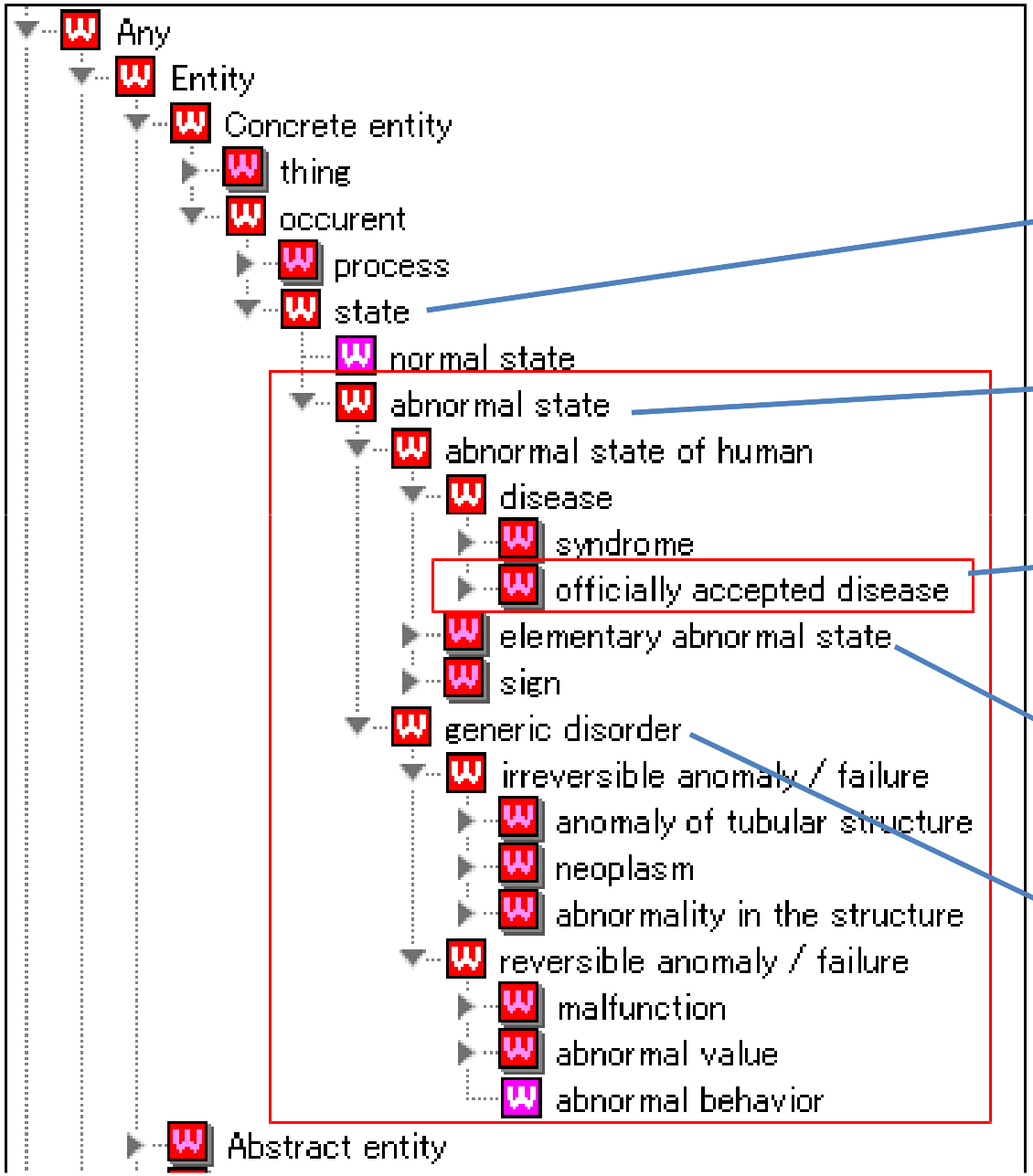
Definition of diseases as a set of 'abnormal state'



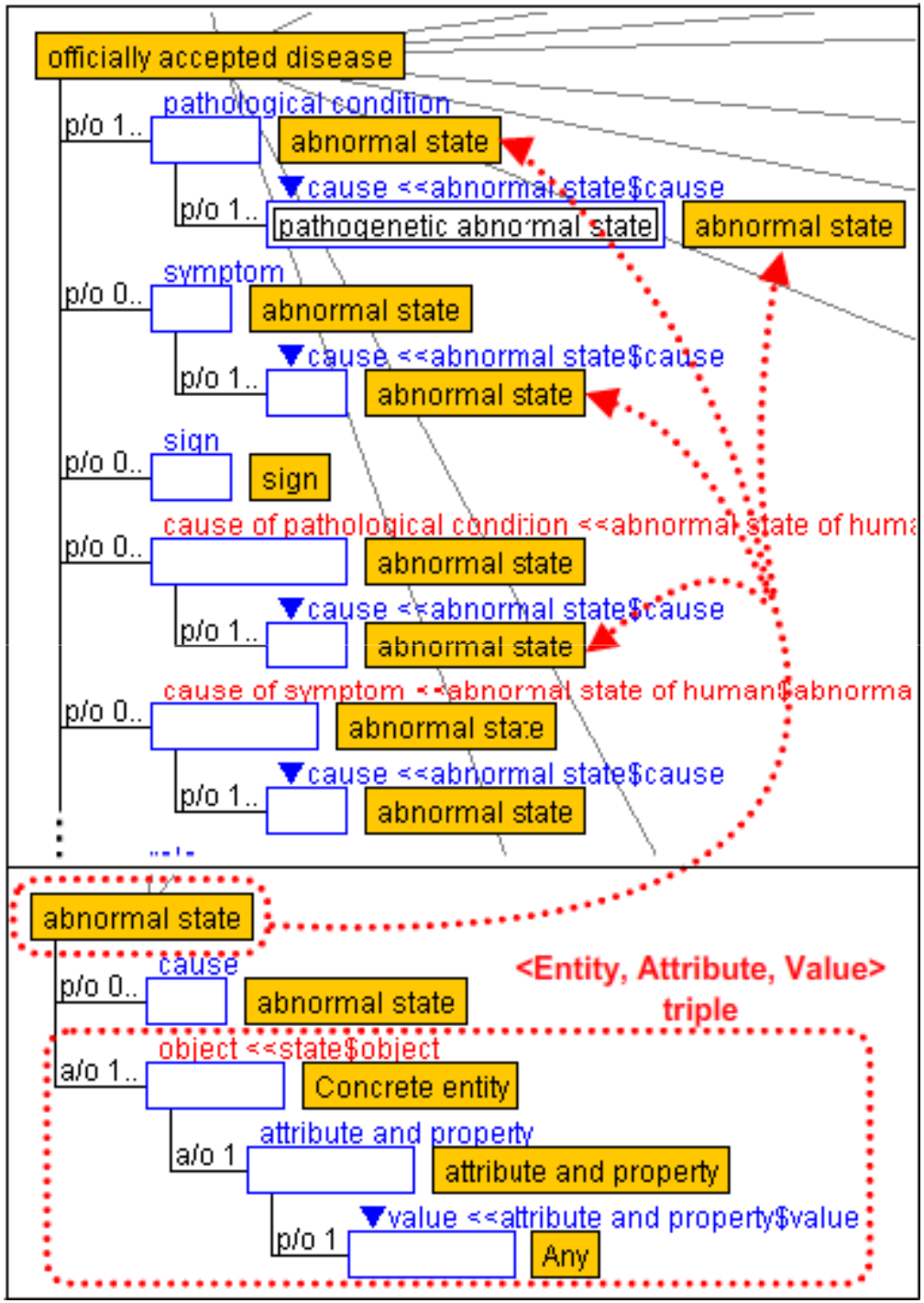
State

Abnormal state

Officially accepted disease

Elementary abnormal state
(glycometabolism disorder,..)

Generic disorder
(swelling, hyperfunction,..)



For defining the properties, each "**Abnormal state**" plays a **role** of:

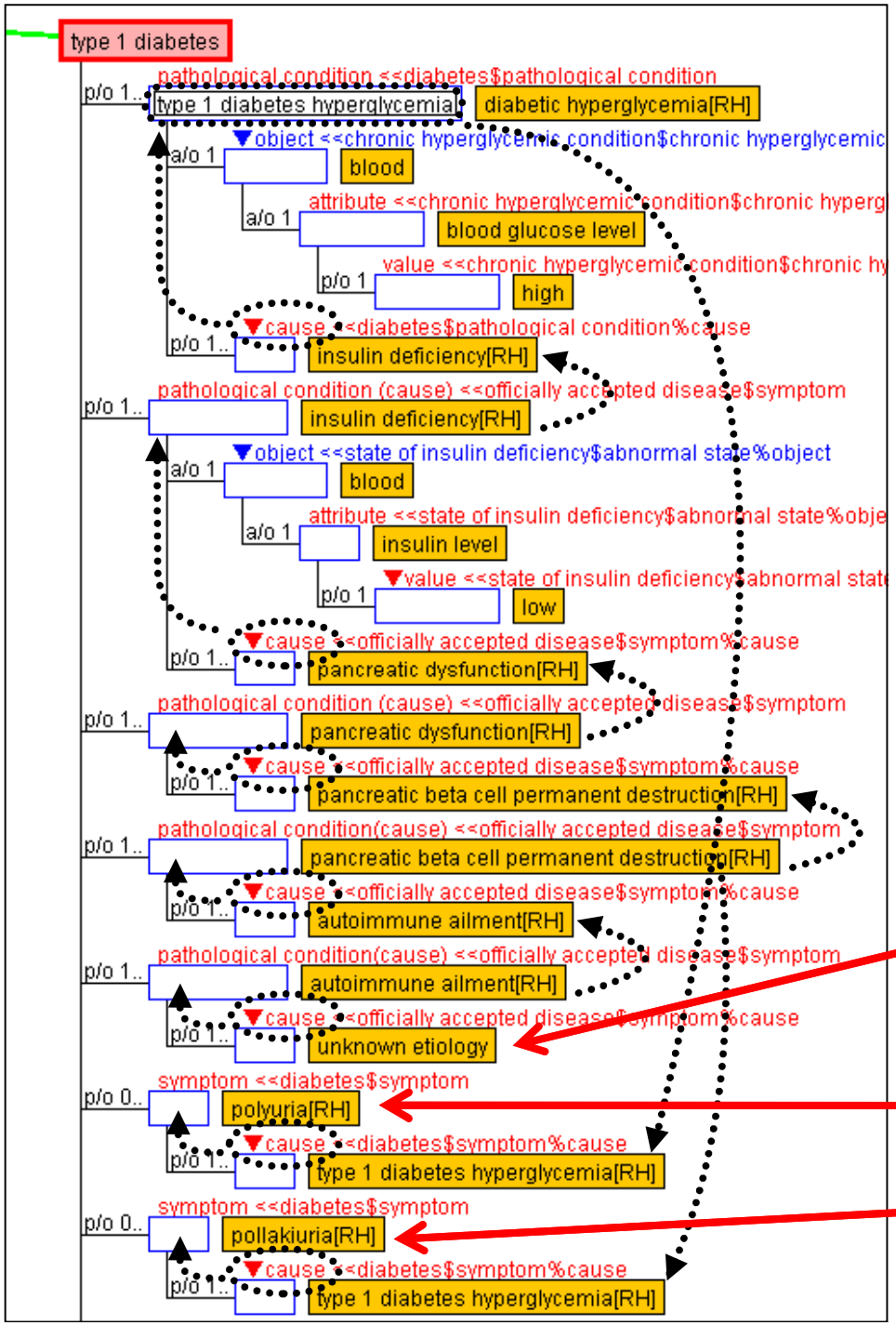
- "Pathological condition"
- "Symptom"
- "Sign"
- "Cause of pathological condition"
- "Cause of symptom"

etc.

Each "**Abnormal State**" is basically defined by the **<Entity, Attribute, Value> triplet.**

(e.g.) "Hyperglycemia"

<E: blood,
A: blood glucose level
V: high>



Definition of ‘Type I diabetes’ & Representation of the etiological chain

[Start]: “Unknown etiology”

“Polyuria” (‘Symptom’ Role)

“Pollakiuria”

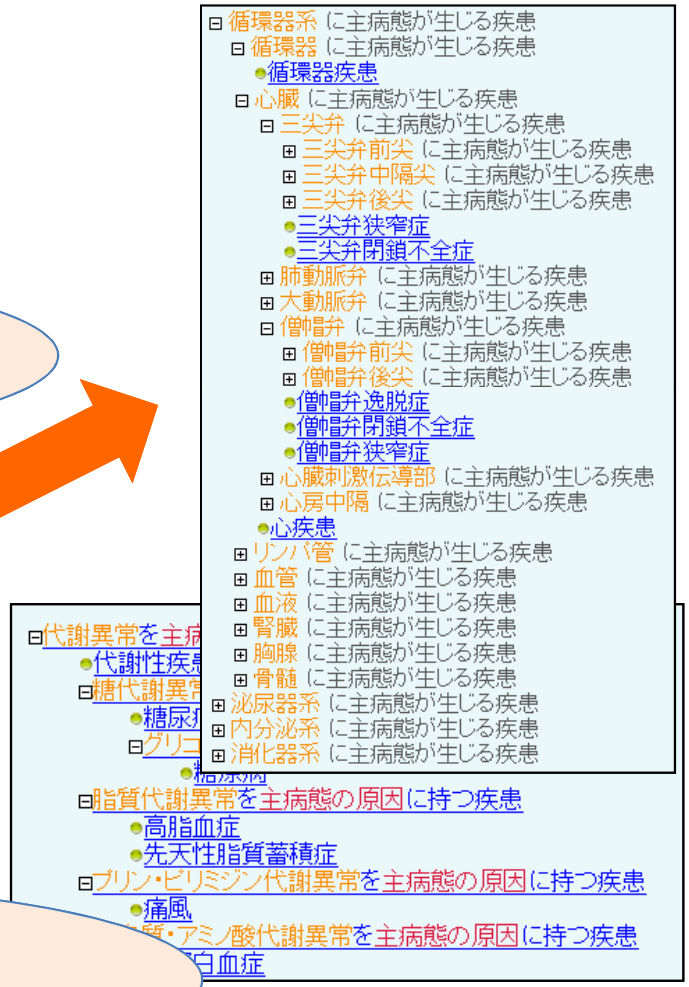
Other important features
- Re-organization of Hierarchical Tree-

- Single vs Poly hierarchical structure
- Problems in Poly-hierarchical structure
- Explicit information about the
  s
  is impo
- We can distinguish the type of 'is-a' relation using the specializati
  information for each sl

Hierarchy rendering
(Specialization of "FindingSite")

Ontology

Hierarchy rendering
(Specialization of "Cause")



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Concluding Remarks (1)

- **Important features** of our ontology

  (1) class constraint, role and role holder
  (2) 'p-' operator
  (3) description framework of disease based on 'officially accepted disease'
  (4) on-demand reorganization of hierarchical tree

- **Advantages of our description framework** compared with others

  (1) explicit representation of 'commonality' and 'specificity'
  → enables compact representation of:
  A) abnormal states shared among the various diseases
  B) common properties shared among organs
  (2) smart description of 'etiological chain'
  → useful for the future machine inferences (e.g. cause-effect reasoning)
  (3) "p-" operator
  → enables property inheritance along part-whole relationship
  in a smarter way than SEP-Tripet / FMA
  (4) on-demand reorganization of the hierarchical tree can be generated dynamically according to the given perspective

Concluding Remarks (2)

- **Current phase:**

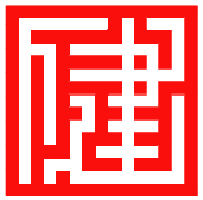
- Increasing definitions of diseases
  * In cooperation with physicians from 10 clinical divisions
  * Using the description support tool based on the framework of 'officially accepted disease'

- The description work for all concepts is expected to be finished in March, 2010

- **Future task:**

- To create mappings between our ontology and other existing ontologies (SNOMED-CT, FMA)
  * Based on the comparison of our description framework and that of others
  * It is also expected to be finished in the near future

Thank you for your attention!



- Takeshi IMAI, Ph.D

<ken@hcc.h.u-tokyo.ac.jp>