Description Logic(s)

- Formerly known as "terminological logic(s)"
- Idea: logic language for
  - defining concepts in terms of other concepts
  - interrelating concepts
  - constraining the meaning of concepts
- DL definition of "Happy Father"

Example: Domain Knowledge to "glue" SYNAPSE & NCMIR Data

Source Contextualization through Ontology Refinement

In addition to registering ("hanging off") data relative to existing concepts, a source may also refine the mediator's domain map...
Roots

- “Structured Inheritance Networks” [Brachman 1977]
- KL-ONE [Brachman, Schmolze 1985]
- Core ideas:
  - Building blocks: atomic concepts (unary predicates), atomic roles (binary predicates), individuals (constants)
  - Constructors for building complex concepts and roles from simpler ones
  - Automated inference for concept subsumption and instance classification (is-a/is-instance-of are not explicitly given by the user, but inferred from concept definitions/instance properties)

Knowledge Base (DL-Style)

- Terminological Knowledge (TBox)
  - Concept Definition (naming of concepts):
    - Spiny_Neuron ⊑ Neuron ⊓ Has_Spine
  - Axiom (constraining of concepts):
    - Neuron ⊑ Has_Compartment

=> a mediators "glue knowledge source"

- Assertional Knowledge (ABox) about Individuals
  - n27_img118 : Neuron

=> the concrete instances/individuals of the concepts/classes that your sources export
Example TBox

Atomic concepts = \{P, F, W, M1, \ldots\}
Base concepts = \{P, F\}
Defined concepts = \{W, M1, M2, \ldots\}
Roles = \{h1, h2\}

Concept Definition
A = C

Base interpretation
J

Extension
II of J

TBox

where A atomic concept.
C, D complex concept expressions

Problem / Exercise

Let the interpretation \( \mathcal{I}(\text{Person}(x)) \) be “x is a person”. 
Similarly, \( \mathcal{I}(\text{Female}(x)) = \text{“x is female”} \). 
Question: What do W, M1, etc. mean?
Back to Reasoning with the Family ...

- concept definition: MyConcept = DL-formula
- concept inclusion: MyConcept ⊆ DL-formula
- finite set of definitions is a terminology or TBox if for every atomic concept A there is at most one axiom whose Lhs is A

Definitorial Terminologies

- In a TBox we distinguish: primitive concepts (occurring only on rhs) and defined concepts (occurring on lhs)
- T is definitorial if every interpretation of primitive concepts yields exactly one model of T (and thus for the defined concepts) → meaning of defined concepts is fixed once the primitive concepts are interpreted!
- A directly uses B in T if B appears in the rhs of the definition of A
- A uses B is the transitive closure of 'directly uses'
- T is cyclic if A uses A for some A; else acyclic

One can show: If T is acyclic then T is definitorial

What about this one?

Human' = Animal' \land\ hasParent:Human'

Expansion of Terminologies

- For acyclic T we can "unfold" concept definitions until every defined concepts is specified in terms of primitive concepts only → the expansion of a TBox T
- Example: