Funding: NIH DC02310

Consultation: Jose L.V. Mejino

Custom Views of Reference Ontologies

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Overview:

Reference ontologies, such as the University of Washington's Foundational Model of Anatomy (FMA), are intended to support the domain knowledge requirements of multiple disparate applications. They are often too large or too complex, however, for any specific application. In addition, the "world view(s)" provided by such reference ontologies may not match exactly the views required by particular applications. In order to utilize reference ontologies, therefore, applications often require custom ontology views tailored for use within their specific context.

Problem:

- As more users have endeavored to adopt the FMA for use within their application contexts, the need for custom view generation has become increasingly evident.
- Previous FMA view generation has, to-date, been rather ad-hoc, often via one-off programs which have not aided in subsequent view generation efforts.

Suppositions:

- There exists a small finite set of operations required for view generation in general.
- Some parts of the view specification and/or generation process can be (semi-) automated.
- It is possible to create a declarative view definition language (VDL), enabling view specification in the general case, supporting the set of operations required for view generation.

Approach:

The goal of this work was to begin the process of cataloging the issues related to and the operation required in the generation of custom ontology views. In support of this goal we performed a case study using a specific view generation task; namely to produce an FMA view that resembled, as closely as possible, the NeuroNames (NN) hierarchical nomenclature for brain structures (human structures only).

Why this should be easy:

- NeuroNames informed the construction of the neurological component of the FMA. Therefore we should expect a large degree of overlap in the structures represented by the two ontologies.
- The NN hierarchy is based on a principle of nested structures. If structure B is spatially contain within the confines of structures A, then structure B is represented as a descendent of A in the NN hierarchy. A similar relationship, *regional part* exists in the FMA (Figure 1).

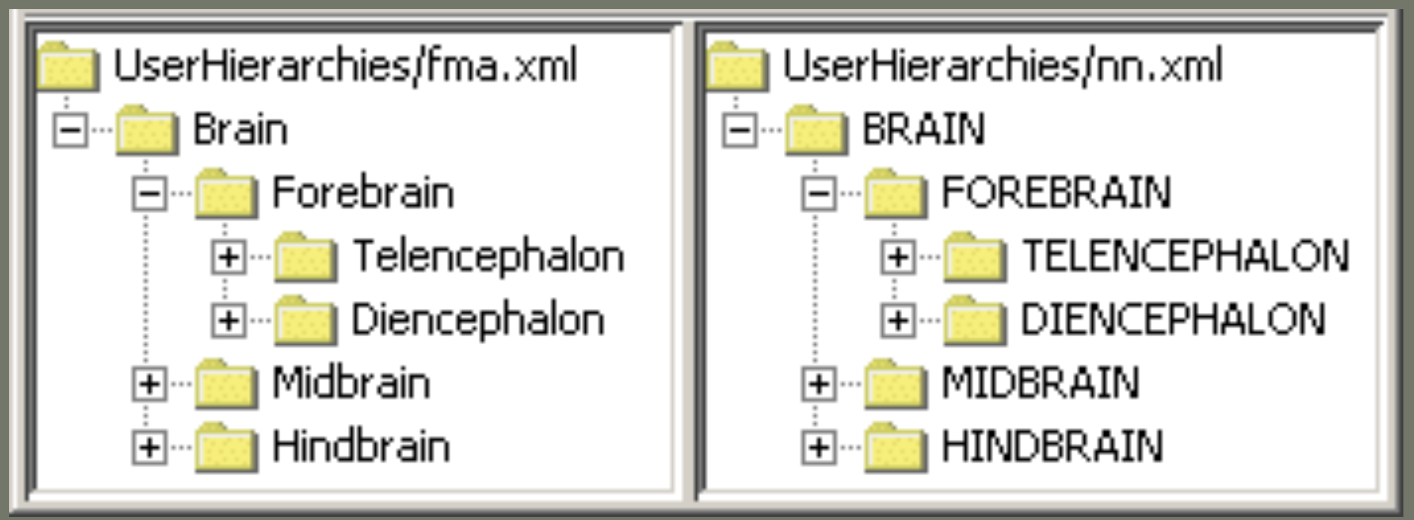

Figure 1: marked correspondence in the regional part hierarchy from the FMA (left) and the upper level neuro-anatomical structures of NeuroNames (right)

Initial approach:

- Path based traversals: transitive closure over *regional part* relationship beginning at the brain
- View construction rules:
  - For FMA set classes (i.e. *Basal ganglia*) include all *member* classes as direct descendents in hierarchy
  - For FMA space classes (i.e. *Fourth ventricle*) include all *contained* classes as direct descendents

Why this wasn't so easy:

- Creating an ontology view to match a pre-existing knowledge source is really an ontology alignment problem
- Path based traversals and general view construction rules were not sufficient

Representational mismatches:

Generating a view of the FMA to match NN required the alignment of entities between the two ontologies (a prerequisite to any reorganization required). A number of fundamental differences between these two models affected our ability to perform such alignments, consider an example:

Cerebral cortex, in NeuroNames, appears as a child of *Telencephalon* (Figure 2). In reality, there is no single continuous structure cerebral cortex. What neuro-biologists commonly refer to as the cerebral cortex is actually the union of two disjoint entities, the outer gray matter layers of the right and left cerebral hemispheres. NeuroNames represents this union as the singular entity *Cerebral cortex*. The FMA, also has a *Cerebral cortex* class, but rather than representing the union of the right and left cerebral cortices, it represents the type or kind for these two classes, much like *Organ* is the type for *Heart*. Just as you would never find *Organ* in an anatomy partonomy (only specific organs) so it is true for the *Cerebral cortex* class in the FMA. The *Cerebral cortex* classes from these two ontologies do not align (Cerebral cortex in NN actually aligns to Set of cerebral cortices in the FMA).

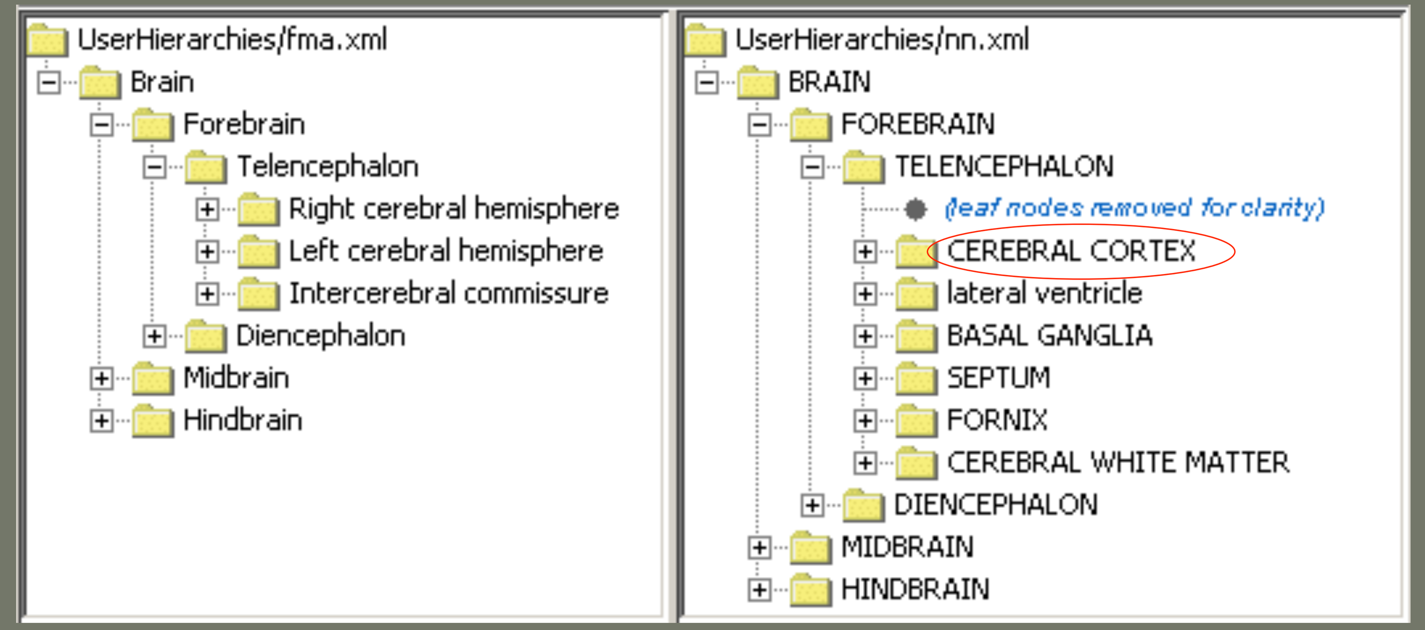

Figure 2: FMA to NeuroNames alignment issue caused by representational mismatch.

In NeuroNames, the *Frontal lobe* is represented as a child of *Cerebral cortex*. This implies that the *Frontal lobe* includes only the gray matter layers of the cerebral hemispheres, which is consistent with the view of many neuro-anatomists and is based on tissue staining. The FMA, however, considers the *Frontal lobe* to also include some white matter, more consistent with a neuro-surgical view. Additionally, like the *Cerebral cortex*, the *Frontal lobe* is two disjoint structures and exhibits the same entity union to entity type mismatch that we saw in the previous example.

The point:

The point of the previous example is to illustrate the unexpected complexities associated with creating custom ontology views, particularly in the case of attempting to match a pre-existing view. Path traversals and construction rules alone are unlikely to be sufficient to handle all special cases. While such operations are certainly useful, a complete and flexible view generation mechanism must also provide manual editing operations, allowing further user customizations.

View operations:

- Path traversals
- View construction rules
- Manual editing operations
  - Add class or property
  - Remove class or property
  - Reorganize (special case of add/remove)
  - Change attribute (i.e. rename class or property)
- Reformat

Conclusions:

Rule based approaches, to custom ontology view generation, are effective, but not sufficient for a flexible and complete view definition language. In this case study we began to analyze and catalogue the sorts of constructions/ operations that are desirable in a VDL.

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