Challenges in Reconciling Different Views of Neuroanatomy in a Reference Ontology of Anatomy

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Abstract

A fundamental requirement for integrating neuroscience data is a well-structured ontology that can incorporate, accommodate and reconcile different neuroanatomical views. Here we describe the challenges in creating such ontology, and, because of its principled design, illustrate the potential of the Foundational Model of Anatomy to be that ontology.

The need to integrate the vast amount of neuroscientific data through neuroanatomical as well as general anatomical ontologies is well-recognized[1]. However, most such *application* ontologies lack the principled structure needed to reconcile the plurality of views of neuroanatomy.

We have previously shown[2] that the Foundational Model of Anatomy (FMA) Ontology[3] possesses the semantic framework for incorporating terms from NeuroNames (NN) and Terminologia Anatomica (TA), which are two of the most widely used terminologies. In the process of incorporating these terminologies we have identified a number of challenges that must be addressed in order to create a reference ontology that can reconcile different views:

1) **Assuring ontological consistency.** For example gray matter, which consists predominantly of cell parts (somas), not cells, cannot be regarded as tissue, since tissue is defined as a collection of cells.

2) **Representing multiple levels of granularity.** Some terminologies primarily target cells, and others macroscopic entities; none, however, span the spectrum of granularity levels in the nervous system.

3) **Reconciliation of diverse contexts.** Different disciplines of neuroscience represent and define neuroanatomical entities in accord with the needs of specific applications: neurosurgeons consider from a structural point of view the frontal lobe to include both the cortex and the underlying cerebral white matter, while neuroscientists limit their functional view of a lobe to the cortex.

Because the FMA is a disciplined approach rooted in the top-level nodes of Basic Formal Ontology[4] and based on a set of guiding principles, it provides a framework that has the facility to resolve many of the issues presented above:

1) Ontological and semantic inconsistencies can be addressed by using formal definitions of high level types to assure proper taxonomic type assignment. For example, in the FMA *Gray matter* is assigned not as a type *Tissue*, but as a type *Cell part cluster.*

2) Granularity is automatically addressed since the FMA taxonomy already encompasses objects from macromolecules to gross structures.

3) Reconciling disparate neuroanatomical contexts remains a difficult challenge, but explicit representations of the types of neuroanatomical entities and their structural relationships within each context can help. As one example, we created the type *Cortex of frontal lobe* to accommodate the functional view, while reserving the type *Frontal lobe* for the structural view. We also included synonyms to accommodate other recognized names for these types.

We are currently working to apply these principles on a larger scale.

References

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