OME Ontology: A Novel Data and Tool Integration Methodology for Multi-Modal Imaging in the Life Sciences

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Abstract. The Open Microscopy Environment (OME) platform OMERO is a web-based platform that realises a secure repository for light microscopy imaging data. Users can view, organise, analyse and share their imaging data. Given the importance of imaging in the life sciences, the imaging data in various datasets, including multi-omics and multi-modal imaging datasets, should be integrated. To this end, we are developing an ontology that integrates these datasets. We have already defined a light microscopy imaging ontology by translating the XML-based OME data model. This ontology has since been extended with a multi-modal imaging ontology with electron microscopy, X-ray computed tomography (CT) and magnetic resonance imaging (MRI) data. In a preliminary investigation, the extended ontology described the multimodal imaging metadata of RIKEN. This poster presents the details of the ontology, and our progress in publishing RDF-based multi-modal imaging metadata.

Keywords: Open Microscopy Environment, microscopy imaging, multi-modal imaging, imaging ontology, semantic life-science data integration

1 Introduction

Imaging technologies are essential for understanding life phenomena and diagnosing diseases. The Open Microscopy Environment (OME; `http://openmicroscopy.org/`) is a consortium of universities, research labs, industry and developers producing open-source software and format standards for microscopy data. The OME provides a de facto-standard imaging tool called OMERO that allows users to view, organise, analyse and share their imaging data. In OMERO, imaging metadata can be written into a relational database based on the OME Data Model, which defines the elements of and relationships amongst metadata related to light microscopy imaging. Metadata that are not directly mapped into the OME Data Model are stored in OMERO using key–value paired annotations. To improve it, a novel framework to describe metadata based on concepts in the OME Data Model, which realises open data such as the FAIR data principals (`https://www.nature.com/articles/sdata201618`), is needed. To support multi-modal imaging technologies and integrate the various life-science metadata, thereby enabling comprehensive image analyses using deeply subdivided knowledge, we generate semantic OME metadata by an ontology and linked open data (LOD) approach. This poster presents our prototype ontology associated with the OME data model, and its extension to electron microscopy, X-ray computed tomography (CT) and magnetic resonance imaging (MRI) data.

2 Ontology design and implementation

We have extracted the core concepts of the OME data model, and detailed them by defining their relationships to the properties. The core concepts are *project*, *experiment*, *instrument*, *image*, *screen*, *plate* and *region of interest* (ROI). Our prototype ontology comprises 116 concepts (classes) and 193 properties. Towards extending our ontology to multi-modal imaging, we are developing electron microcopy, X-ray CT and MRI ontologies. A combined ontology was preliminarily proposed by researchers at RIKEN, who introduced specific imaging concepts and biosamples. The RIKEN ontology includes both biosampled and image-derived phenotypes, and comprises 276 concepts and 173 properties. RIKEN tested whether their extended ontology can describe the metadata of imaging experiments by the LOD approach. As an electron microscopy meta-database, we have developed the RIKEN Microstructural Imaging MetaDatabase based on the RIKEN MetaDatabase (`http://metadb.riken.jp`). The Microstructural Imaging MetaDatabase publishes approximately 1,000 images of tissues such as brain, heart, liver and kidney in humans, mice and rats, along with their metadata. For this purpose, it provides a stepless magnification image viewer. Using the X-ray CT and MRI concepts, researchers can develop novel phenotypic analysis methods for soft tissues and structural and functional marmoset brain atlases, respectively. Currently, the extended ontology has been carefully examined by RIKEN and OMERO collaborative groups. The ultimate goal is an extensible and community-driven standardised ontology.

3 Discussion and future directions

We introduced a multi-modal imaging ontology based on the OME data model. We foresee adding support for this ontology to the OMERO platform as the future basis for multi-modal imaging, whereby users can manipulate various imaging data on a single interface. Furthermore, our ontology integrates other life-science metadata such as combined genome and phenome omics datasets, enabling comprehensive imaging analysis.

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