The ManRay Project: Initial Development of a Web-Enabled Ontology for Nuclear Medicine

Carl Taswell*, Benjamin Franc, and Randall Hawkins

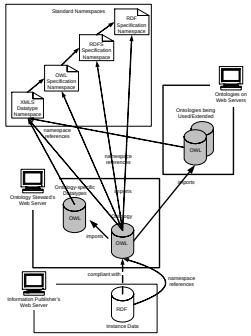
Nuclear Medicine, Department of Radiology, University of California San Francisco, * Corresponding Author

Introduction

The semantic web extends the original web with technologies that provide syntactic structure (XML) and semantic meaning (RDF) permitting the development of taxonomies and inference rules (Berners-Lee et al, 2001). These technologies together with the Web Ontology Language (OWL) enable the compilation of knowledge representations or collections of information known as ontologies. Biomedical ontologies have benefited from significant development in the bioinformatics and clinical informatics communities (Pinciroli et al, 2005). In contrast, there appears to be a relative dearth of progress in the specialty fields of nuclear medicine and radiopharmaceutics. With the exception of some work on a radiopharmaceutical information database (Blaine et al, 1999) which did not involve any semantic web technologies nor any internet technologies, extensive literature searches have not found any other nuclear medicine informatics projects. The ManRay project attempts to fill this gap.

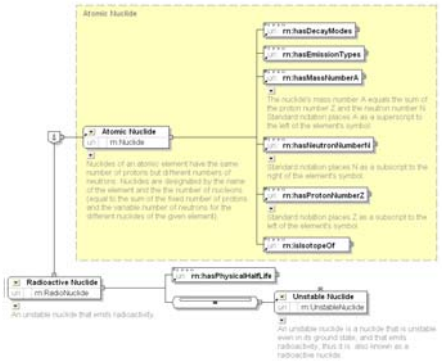
Method

Ontologies for the ManRay project are constructed adhering to (1) the specifications for XML, RDF, and OWL recommended by the World Wide Web Consortium (www.w3.org), (2) the usage paradigm advocated by Lacy (see diagram on page 144 of his 2005 book on OWL, reproduced here with permission of the author), and (3) general software engineering principles of hierarchical modularity, flexibility, and extensibility.



Development is guided by the "ontology steward" paradigm in which the steward hosts and manages the ontology standard but does not necessarily provide a database distributing data compliant with the standard. Thus, the steward's web server publishes the ontology as a *.owl file while other publishers distribute their data as compliant *.rdf files that reference the ontology steward's *.owl file.

ManRay RadioNuclide Class



Example of Element Class Instance

OWL Markup for Rubidium Example

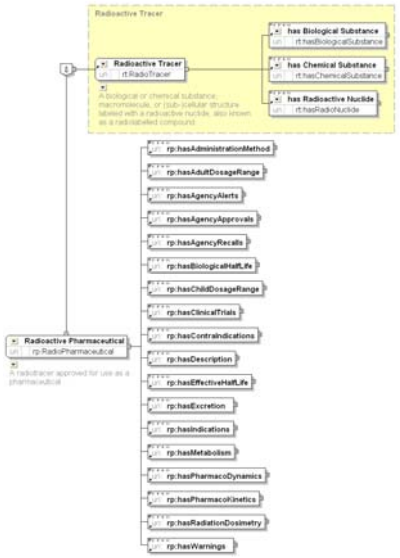
```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE rdf:RDF [
  <!ENTITY owl "http://www.w3.org/2002/07/owl#">
  <!ENTITY rn  "http://www.nucmedlib.org/namespace/ManRay/radionuclide.owl#">
  <!ENTITY rdf "http://www.w3.org/1999/02/22-rdf-syntax-ns#">
  <!ENTITY xsd "http://www.w3.org/2001/XMLSchema#">
]>
<rdf:RDF xml:base  ="rn:RadioNuclideOntology"
         xmlns:owl ="owl:"
         xmlns:rn  ="rn:"
         xmlns:rdf ="rdf:">

  <owl:Class rdf:about="#Element"/>
  <owl:DatatypeProperty rdf:about="#hasAtomicMassA"/>
  <owl:DatatypeProperty rdf:about="#hasAtomicNumberZ"/>
  <owl:DatatypeProperty rdf:about="#hasAtomicSymbol"/>
  <owl:DatatypeProperty rdf:about="#hasStableNuclides"/>

  <rn:Element rdf:about="#Rubidium"
              rn:hasAtomicMassA="85.5"
              rn:hasAtomicNumberZ="37"
              rn:hasAtomicSymbol="Rb"
              rn:hasStableNuclides="true">
    <rdf:type rdf:resource="owl:Thing"/>
  </rn:Element>

</rdf:RDF>
```

ManRay RadioPharmaceutical



ManRay NucMedProcedure

Results

The ManRay project implements an ontology for nuclear medicine, radiopharmaceutics, and molecular imaging structured as a hierarchy of *.owl files with manray.owl as the top level and separate *.owl files for imaging protocols, pharmaceuticals, and radionuclides as the lower levels. The current package (version 0.1) provides an initial framework with preliminary versions of the following files: manray.owl, nucmedprocedure.owl, nucmedequipment.owl, radiopharmaceutical.owl, radiotracer.owl, radionuclide.owl, squ.owl, and crc.owl. The website www.nucmedlib.org hosts the ManRay project and its ontology.

Applications

An ontology provides an open standard for the exchange of data (stored in offline repositories or published via web sites and web services) and enables the interoperability of applications that can communicate in the same language. Investigators in nuclear medicine will be able to exchange information efficiently as they develop new radiopharmaceuticals and conduct clinical trials of diagnostic imaging and therapeutic radioablation procedures. As the semantic web evolves, new query and analysis tools built on the foundations of underlying ontologies will become available enabling sophisticated artificial intelligence based searches that efficiently yield directly relevant answers to questions (contrary to the current situation with a "dumb" or "blind" search on Google). See the upcoming Protégé 2006 Conference for examples of medical ontologies for designing clinical practice guidelines and grading lung tumors.

Conclusion

Development and promotion of a nuclear medicine ontology as an open standard for the exchange of data constitutes the most important goal of the ManRay project. Establishment of this ontology will enable the subsequent development of informatics applications capable of performing inference, such as automated meta-analyses, on data published according to the standard. Individuals and/or organizations interested in contributing to the ManRay project are encouraged to contact the authors.