

# BioPortal: Ontologies and Data Resources with the Click of a Mouse

M. A. Musen,<sup>1</sup> N. H. Shah,<sup>1</sup> N. F. Noy,<sup>1</sup> B. Y. Dai,<sup>1</sup> M. Dorf,<sup>1</sup> N. Griffith,<sup>1</sup>  
J. Buntrok,<sup>2</sup> C. Jonquet,<sup>1</sup> M. J. Montegut,<sup>1</sup> and D. L. Rubin<sup>1</sup>

<sup>1</sup>Stanford Center for Biomedical Informatics Research,  
Stanford, California 94305-5479

<sup>2</sup>Division of Biomedical Informatics, The Mayo Clinic, Rochester, MN 55905

## Background

Ontologies provide domain knowledge to drive data integration, information retrieval, natural-language processing, and decision support. The National Center for Biomedical Ontology, one of the seven National Centers for Biomedical Computing created under the NIH Roadmap, is developing BioPortal, a Web-based system that serves as a repository for biomedical ontologies. BioPortal defines relationships among those ontologies and between the ontologies and online data resources such as PubMed, ClinicalTrials.gov, and the Gene Expression Omnibus (GEO). BioPortal supports not only the technical requirements for access to biomedical ontologies either via Web browsers or via Web services, but also community-based participation in the evaluation and evolution of ontology content. BioPortal enables ontology users to learn what biomedical ontologies exist, what a particular ontology might be good for, and how individual ontologies relate to one another.

The BioPortal system is available online at the following location: <http://bioportal.bioontology.org>.

## System Description

The BioPortal repository stores several dozen ontologies, and users add new content regularly. Ontologies currently may be represented in OWL, OBO Format, or the Protégé frame language.

The BioPortal repository includes the entire Open Biomedical Ontologies library, as well as important clinical terminologies and ontologies, such as BIRNLex and RadLex. BioPortal allows users to browse these ontologies in a standard tree view or to visualize the content in a nodes-and-links diagram. Incorporation of the Jambalaya ontology-visualization system from the University of Victoria offers sophisticated graphics and animation for cognitive support of ontology navigation.

The BioPortal system is much more than a static repository. Registered users of BioPortal can write to the ontology store, enhancing the content in the repository in a Web 2.0 fashion. For example, users of BioPortal can comment on any ontology in the repository, adding a

*marginal note* that offers feedback to other potential users of the ontology and to the ontology developers. Other users can comment on any marginal note in the system, facilitating threaded discussions of BioPortal ontologies at different levels of granularity. Marginal notes provide the equivalent of community-based peer review of ontologies, and allow ontology developers to store their design rationale explicitly as metadata associated with the relevant ontology.

Registered users of BioPortal can also augment the content in the archive by defining mappings between the entities in one ontology and those in another. Such mappings may be simple point-to-point mappings that users enter when browsing ontologies (e.g., specifying that, say, *tail* in the Mouse Anatomy Ontology should be mapped to *tail* in the Rat Anatomy Ontology). Other mappings may be created “in bulk” using a tool such as the PROMPT plug-in for Protégé and then uploaded to BioPortal as a group.

An important feature of BioPortal is its link to a facility known as Open BioMedical Resources (OBR). OBR automatically indexes important biomedical data sets available online (e.g., entries in PubMed, GEO, ClinicalTrials.gov) on the basis of metadata annotations, and links the underlying data sets to the terms in the ontologies in BioPortal. These linkages take advantage of the semantic relationships in BioPortal, including subsumption relationships among ontology entities and mappings among ontologies. OBR thus allows biomedical investigators to use the terms in the BioPortal ontologies to search for relevant online data in a manner that is not possible with conventional key-word search strategies.

## Conclusion

BioPortal offers investigators and clinicians “one-stop shopping” on the Web for important biomedical ontologies. The incorporation of a variety of Web 2.0 features allows the system to behave not only as a comprehensive ontology repository, but also as general infrastructure to support community-based access, peer-review, mapping, and annotation of ontology content.

