An Ontology-based Image Repository for a Biomedical Research Lab

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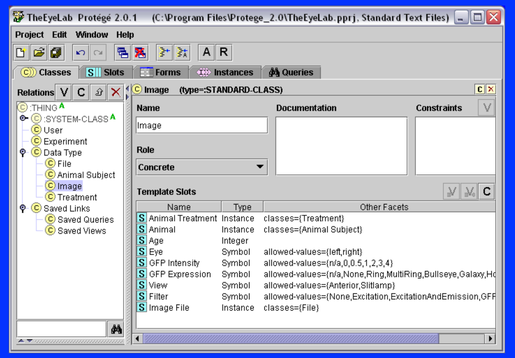

Figure 1: Ontology built in Protégé modeling experimental research data. Screenshot shows the slots of an ontology class that describes the context of a mouse eye image.

Introduction:

We have developed a web-based database for managing images acquired by a biomedical research lab studying the factors controlling cataract development. The Image Repository is a component of an Experiment Management System being built to address the information needs within the laboratory. Based on an evolving ontology we are developing for describing the experimental data collected in the lab, the image repository allows lab members to organize image data by multiple attributes. Customized views of the data allow the researchers to easily compare images based on various parameters. The use of the system has helped make retrieval and analysis of data more efficient and facilitates data sharing with other researchers.

An experiment ontology (Figure 1), which is implemented in Protégé (http://protege.stanford.edu), formalizes the data types associated with particular experiments being performed in a biomedical research lab studying cataracts (also known as The Eye Lab). Among these data types is a representation of digital images of mouse eyes used to document the aggregation pattern of a particular protein under different conditions. The Image Repository tool provides lab members with a web-based interface for storing experiment data into a relational database. The database schema for the Image Repository (Figure 2) is based on the experiment ontology. The schema design enables the automatic creation of an interface that allows the end users to easily manipulate, query and view data in the database.

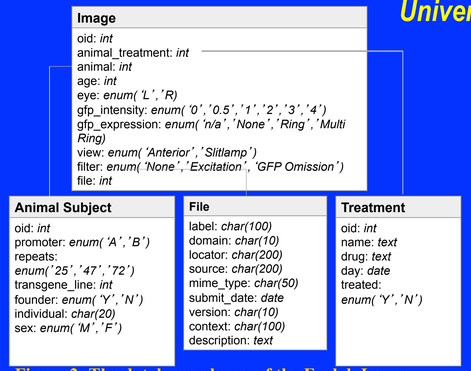

Figure 2: The database schema of the Eyelab Image Repository is based on the experiment ontology built in Protégé

The Image Repository is implemented on top of WIRM (http://www.wirm.org), an open source experiment management system we initially created for managing brain mapping data. Features added to WIRM consider the specific needs and requests of the lab members performing the cataract research experiments. The Image Repository is made up of Perl CGI scripts that call WIRM library functions as well as newly created library functions. These functions use existing Perl modules to talk to the underlying mySQL database (Figure 3).

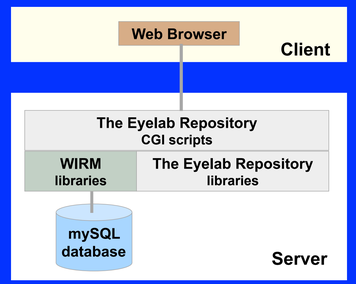

Figure 3: Architecture of the Eyelab Repository System

The features of The Eye Lab Image Repository include:

- **A method for organizing data from different experiments by associating particular experiments with particular data types (Figure 4)**
- **A user interface that allows the lab members themselves to evolve the database schema (Figure 5)**
- **A user interface that facilitates the entry of multiple data items (Figure 6)**
- **A method for creating customized views of data such that data can be easily compared for analysis (Figure 7)**

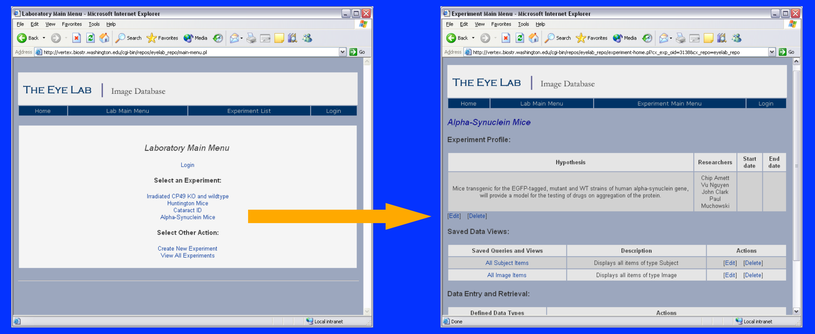

Figure 4: Organization of data by experiment. Each experiment appears to use its own database.

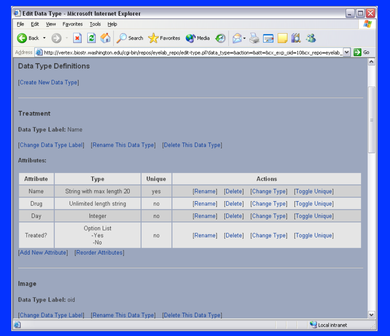

Figure 5: User interface to evolve database schema

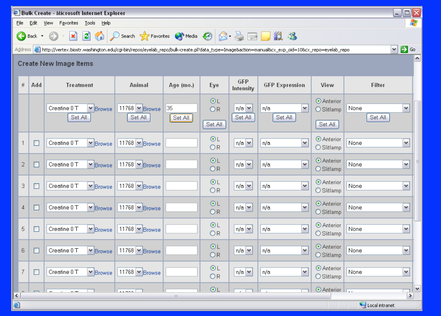

Figure 6: Adding multiple items from a single page

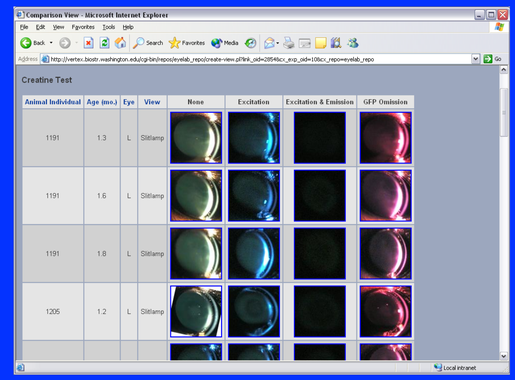

Figure 7: A custom created view displaying images to compare side by side

The members of the research lab have created repositories to store data for four different experiments. They have entered over 1800 items into the entire database, including data describing over 100 animal subjects and over 1600 images taken of the eyes of these animals. The lab members have been able to use the web interface to effectively create and evolve the database schemas that describe their experimental research data. They currently use the interface for entering multiple items at once to help improve data entry efficiency. The most common use of the system is to automatically generate comparison views such as in Figure 7 in order to analyze the results of the experiments. Before the use of the system, the lab members were creating similar views manually using spreadsheets.

Although different experiments require different database schema representations, the schemas have been very similar for the four experiment repositories. We therefore plan to create template schemas that would help the lab to create representations more efficiently and more consistently. We also plan to use the templates to allow researchers to relate items with similar data types from different experiments.

Summary of Conclusions:

Basing a database schema on an experiment ontology we constructed, we created an Image Repository tool that lets researchers easily add, query and view data in a database using an automatically created web based interface. The workflow and specific needs of the lab were considered by adding tool features such as organizing data by experiment, user evolvable schemas, bulk data entry and custom views of data.