Informatics for Integrating Biology and the Bedside (i2b2) is one of the sponsored initiatives of the NIH Roadmap National Centers for Biomedical Computing (http://www.bisti.nih.gov/ncbc/). One of the goals of i2b2 is to provide clinical investigators broadly with the software tools necessary to collect and manage project-related clinical research data in the genomics age as a cohesive entity—a software suite to construct and manage the modern clinical research chart.

Communication of data through a common messaging protocol is essential to be able to create interoperable software tools in the bioinformatics field. The i2b2 Hive, composed of fundamental cells (or modules) allows this open-communication to occur through web services and XML messages. The loosely coupled system consists of five necessary cells that make up the core of the i2b2 Hive: File and Data Repository, Security, Ontology, and Identity Management. The initial open source release will include these required cells. In addition to the core structure, other cells can be attached for further interactive functionality, shown in Figure 1. A sample cell has already been release for pulmonary function test (PFT) processing.

**Figure 1: The i2b2 Hive**

The architecture of the five core cells is written in Java. The cells containing a front-end client are written using the Standard Widget Toolkit (SWT) which enables the user to maintain the standard look-and-feel of their native OS whether on the Mac OS, Windows, Linux, Solaris, or others. The i2b2 workbench front-end is shown in Figure 2. The backend of the five core cells are written using Java J2EE specifications. Apache Axis2 allows for the communication between cells using either REST or SOAP. A level below the Axis2 consists of JAXB (Java Architecture of XML Binding), which maps the XML that is either responded or requested from the cell into Java objects.

**Figure 2: Screenshot of i2b2 Workbench**

Due to the sensitive nature of the work within The Hive, high levels of security are crucial. Without compromising the security integrity, implementation was selected based on ease of use and standards. It is built to comply with the HIPAA security regulations. For example, protected health information that is saved within the data repository cell is encrypted based on the block cipher Advanced Encryption Standard (AES) and the coded medical record numbers are mapped only within the secure Identity Management cell.

All cells in the i2b2 Hive communicate using standard i2b2 XML messages. This message specifies certain properties that are common to cells and essential to the administrative tasks associated with sending, receiving and processing messages. This allows for the ability for supplemental cells to be developed using other languages such as Microsoft .NET, Perl or Python. Ultimately, any language that has the capability of communication via SOAP or REST can be programmed to function as an i2b2 cell; with such a powerful standard, the potential development of further vital extensions can be realized.

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