

# Efficient Web-Based Navigation of the Foundational Model of Anatomy

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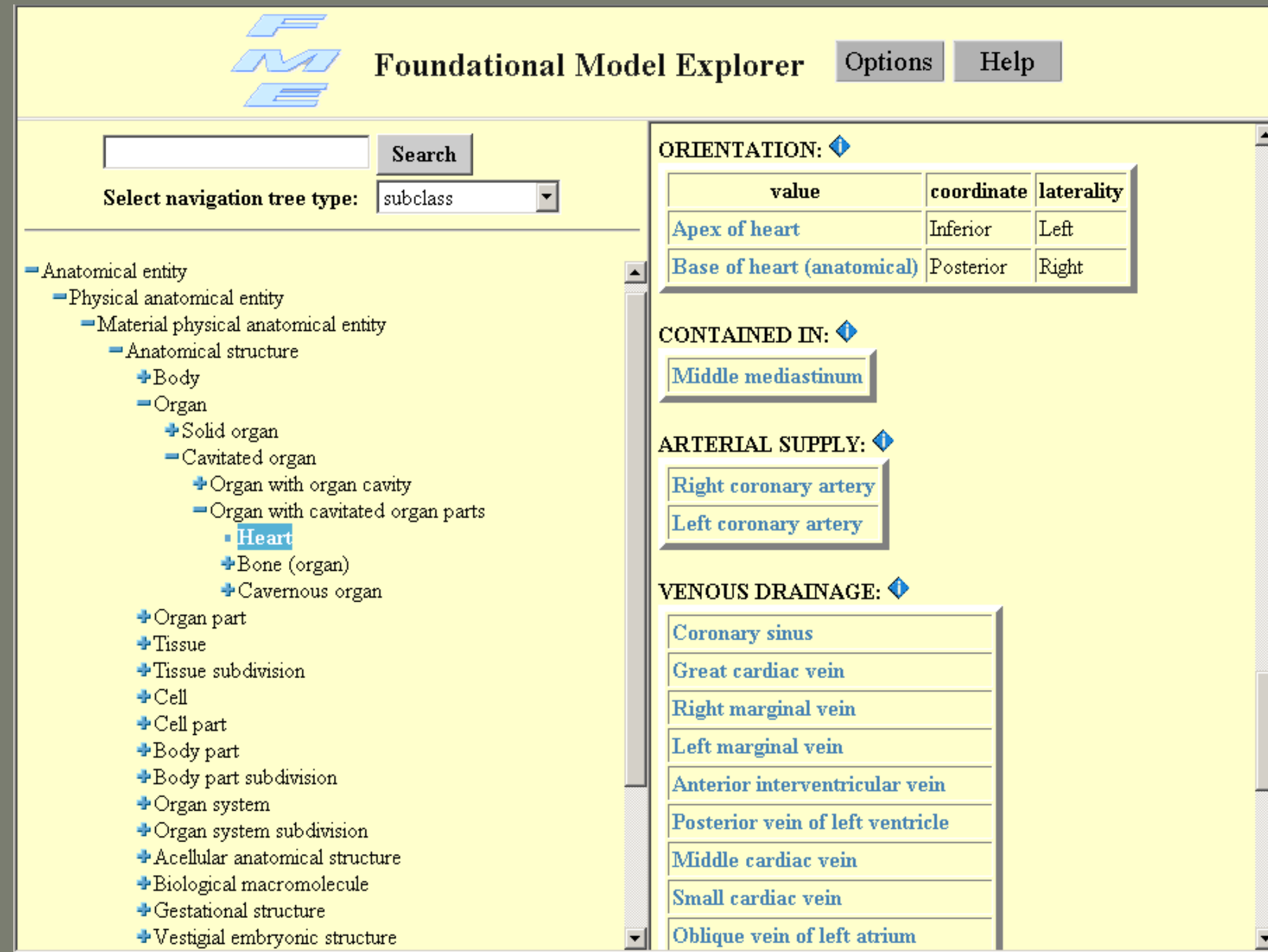


Figure 1: FME Interface

## Introduction:

The University of Washington's Foundational Model of Anatomy (FMA) is an anatomical reference ontology for bioinformatics. Represented by a complex, frame-based model, the FMA is composed of over 180,000 frames. More than 1.5 million slot values collectively describe this set of concept frames. Stanford University's Protégé 2000 knowledge modeling environment, through which the FMA knowledge base is created, was designed for constructing and accessing frame-based knowledge sources. While Protégé 2000's built in interface is ideally suited for knowledge modeling purposes, it is too complicated for some FMA user groups. In addition, the Protégé 2000 interface requires installation and configuration before it can be launched. The Protégé 2000 library does provide an API, however, upon which new knowledge base application can be built. The Foundational Model Explorer (FME), which utilizes this knowledge base access library, was designed to provide simple, intuitive, and efficient web-based access to the Foundational Model of Anatomy.

## Interface:

- Set of hierarchical trees allows users to navigate anatomical concepts along several different organizational axes (subclass, part, regional part, constitutional part, systemic part, branch, and tributary; see Figure 2.)
- Concept pane displays structural information (slots and slot values) for the selected anatomical concept
- Search field facilitates fast location of a concept within the selected hierarchy

## Navigational Hierarchies:

- Pull-down menu allows user to select between members of a set of navigational hierarchies
  - Set membership is dependent on the currently selected concept
  - Selected hierarchy reveals only root concepts whose descendants include the currently selected concept

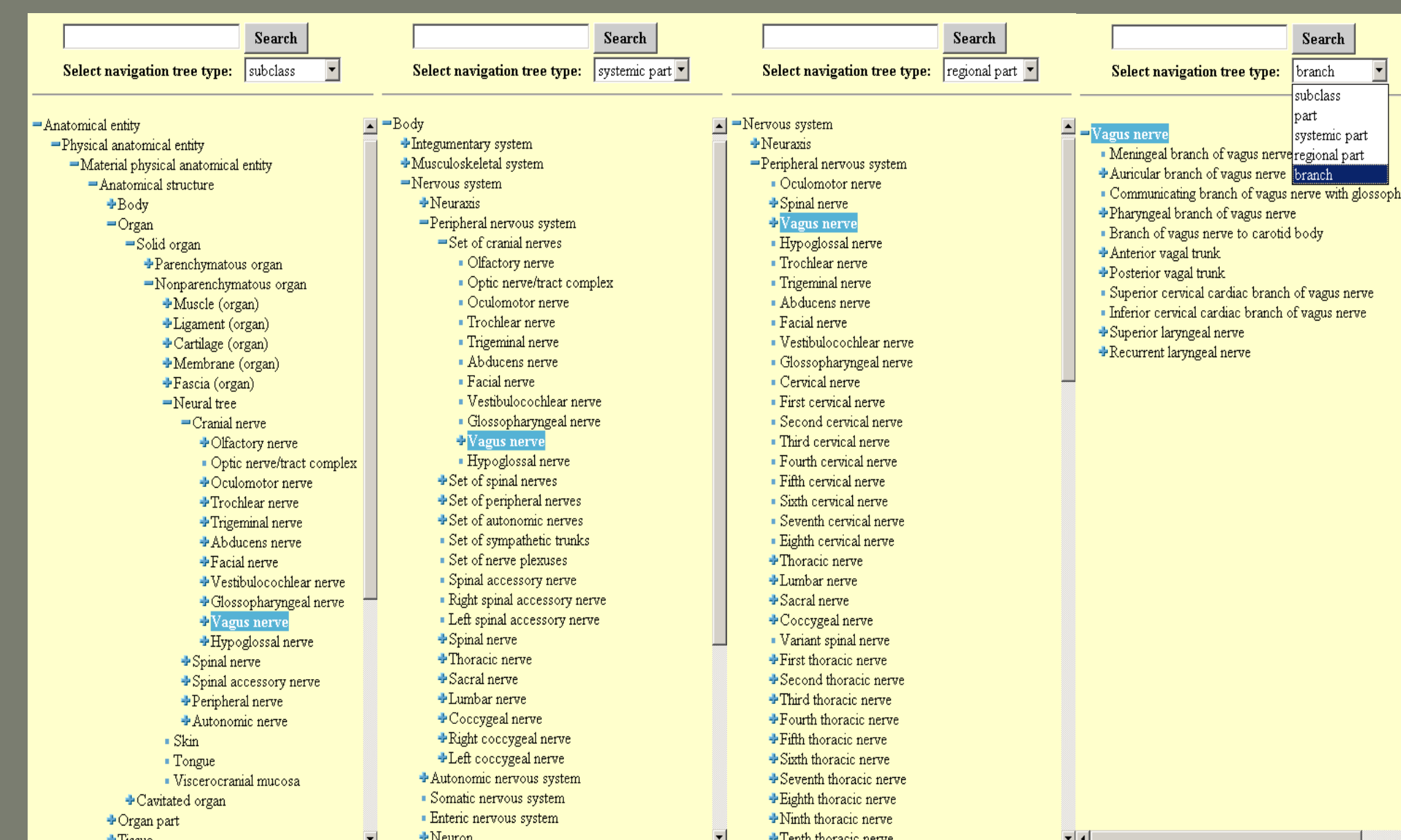


Figure 2: Navigational Hierarchies

## Concept Pane:

- Provides concept information for currently selected concept (slots and slot values)

- Automatically determines which slot values are of type class and represent these as hyperlinks
  - When activated hyperlinks cause not only the concept pane to update but will expand the current hierarchy to all occurrences of the selected concept

## Search Field:

- Locates classes based on their synonyms and non-English equivalents, as well as by their preferred name
- Performs both direct and wild card searches
- Successful search triggers both the concept pane to be updated and the navigational hierarchy to be expanded to all occurrences of the located concept

## Architecture:

- Standard web browser serves as universal thin client
  - No downloading, installation, or user configuration is required
- Knowledge base interaction facilitated by Stanford University's Protégé 2000 knowledge base access library (<http://protege.stanford.edu/>)
- Server-side application architecture
  - Minimizes impact on client resources (i.e. CPU)
  - Maximizes browser support
  - Constructed using Java Server Pages (JSP)
  - Served via the Jakarta Tomcat servlet container [<http://jakarta.apache.org/tomcat/>]

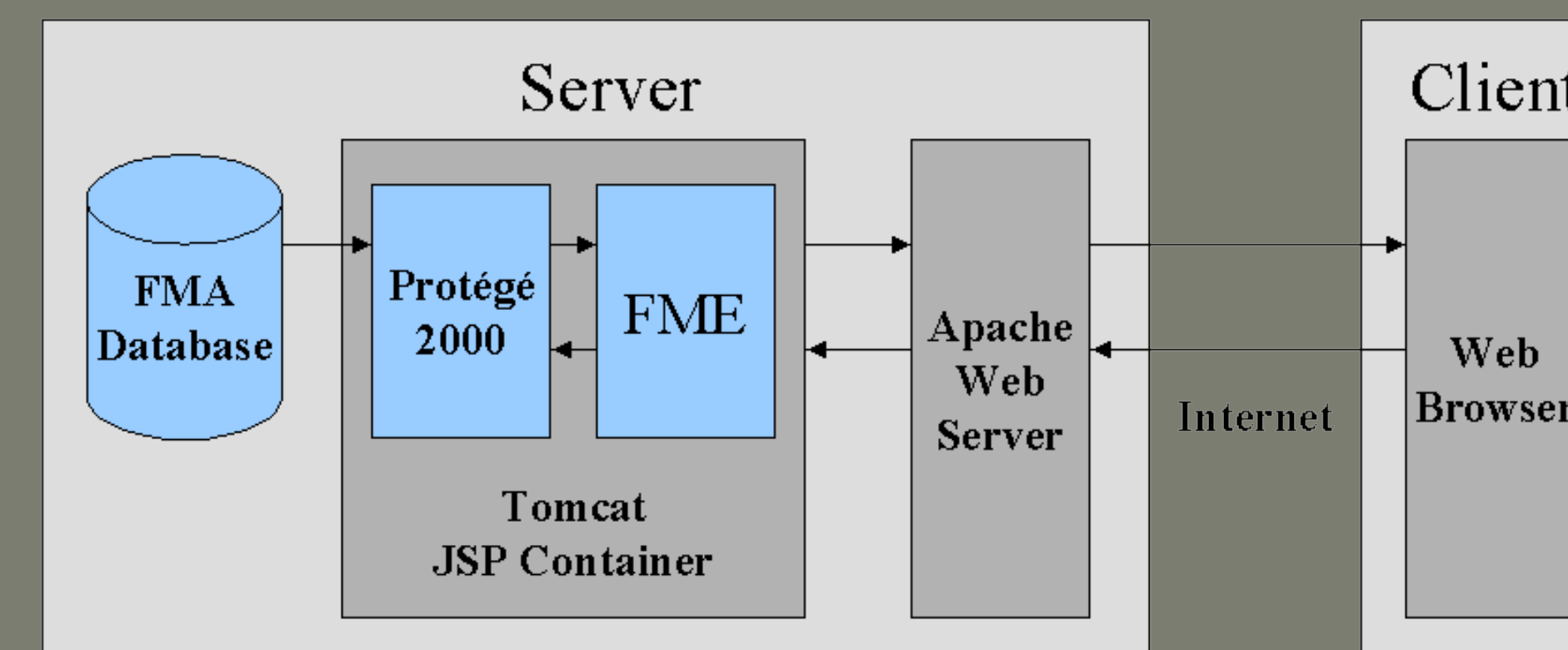


Figure 3: FME Deployment

## Efficiency:

- Utilizes information pre-caching extension to Protégé 2000 provided by Jack Keel of the University of Wisconsin
  - Minimizes database retrieval operations by pre-retrieving data that is likely to be requested next
- Provides menu options for users with slower connection speeds
- Preloads all tree hierarchies in server memory
  - All clients share these data structures
  - Each client maintains its own view information (i.e. which hierarchy is the currently selected hierarchy and which nodes are expanded)

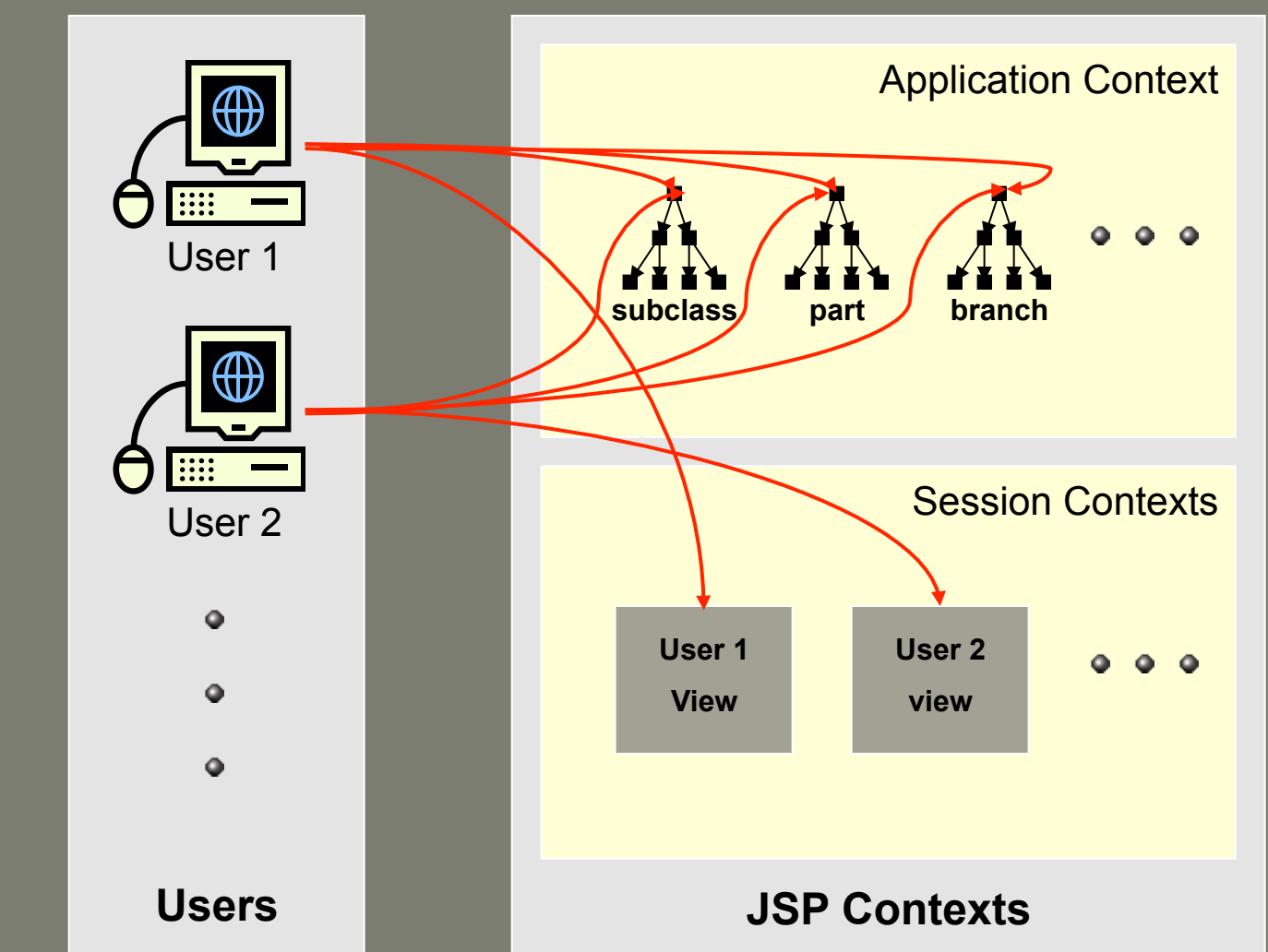


Figure 4: Tree Hierarchy Storage and View

## Summary of Conclusions:

The Foundational Model of Anatomy is a large and complex anatomical knowledge base. Utilizing the Protégé 2000 knowledge base access library, the Foundational Model Explorer is able to leverage the advantages of a frame-based representation of the FMA database. The FME, however, was constructed to circumvent some of the limitations of Protégé 2000's built-in, stand-alone interface. The result is a simple, efficient, web-based browser, that allows user to easily explore the depths of the FMA.