Ontology Visualization as a Service

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University of Victoria
Our goal: Provide **cognitive support** for ontology developers and users through visual and intelligent user interfaces

Methodology:

- Observe and learn what users do
- Develop tools that provide cognitive support
- Evaluate the tools and improve understanding of the users’ needs
Subprojects

- Improve ontology navigation
  - Studies, observational and logging
  - *Search* (integration of *Diamond*) and *FlexViz* improvements
- Provide cognitive support for mapping
  - *CogZ* (recap)
  - A move towards the Web, *Mapping Explorer*
- Visualization as a service
  - *BioMixer*: Mashup/Visual Analytics interface

Previous work: *CTExplorer* and *CTSearch*
NAVIGATION
Ontology navigation

Goal: provide cognitive support for users navigating and exploring ontologies

Ongoing research questions:

- How to improve support for navigation of ontologies such that the cognitive load of the user is reduced?
  - Internal processes?
  - What is difficult/simple?
  - What do/don’t existing tools support well?
Studies

- **Goal**
  - Develop a **cognitive support framework** on navigation
  - Support tool research: Diamond, Search and FlexViz

- **Two observational studies**
  - **Protégé**
    - undirected observations of real users’ tasks
    - 3 participants, experts with Protégé
  - **BioPortal**
    - directed and undirected observations of users
    - 8 participants (non experts)

- **Logging** study of BioPortal users (in progress)
  - Only examined FlexViz and Search data so far
Selected findings from BioPortal studies (1)

- More effective **user control** while loading and navigating ontologies (cancel, auto scrolling)
- Importance of **search** – features for searching multiple ontologies and searching within an ontology
- Improved support needed for displaying and navigating **mappings**
- Interest in **developer tools**
Observational Studies: Findings (2)

- Three themes emerged related to cognitive support for navigating ontologies
  - Navigating ontology **boundaries**
  - Navigating **evolving** ontologies
  - Exploring **unfamiliar** ontologies
Logging data (1)

Flexviz and Search data from July 22\textsuperscript{nd} 2009 until February 14\textsuperscript{th} 2010:

### Unique Daily Visitors:

<table>
<thead>
<tr>
<th>Service</th>
<th>Average</th>
<th>Total Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic FlexViz</td>
<td>31</td>
<td>6000</td>
</tr>
<tr>
<td>Full FlexViz</td>
<td>8</td>
<td>1500</td>
</tr>
<tr>
<td>Search</td>
<td>16</td>
<td>2200</td>
</tr>
</tbody>
</table>

### All Daily Visitors: (repeat visits from same users)

<table>
<thead>
<tr>
<th>Service</th>
<th>Average</th>
<th>Total Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic FlexViz</td>
<td>81</td>
<td>16000</td>
</tr>
<tr>
<td>Full FlexViz</td>
<td>20</td>
<td>4100</td>
</tr>
<tr>
<td>Search</td>
<td>69</td>
<td>9800</td>
</tr>
</tbody>
</table>
Which navigational features are used to explore ontologies?

**Locomotional Features**

- **Graph Selection**
  - Infrequent Users: 180%
  - Frequent Users: 100%
- **Search**
  - Infrequent Users: 140%
  - Frequent Users: 80%
- **Tree Selection**
  - Infrequent Users: 120%
  - Frequent Users: 60%
- **Graph Expand**
  - Infrequent Users: 100%
  - Frequent Users: 50%
- **Tree Expand**
  - Infrequent Users: 80%
  - Frequent Users: 40%
- **Zoom**
  - Infrequent Users: 60%
  - Frequent Users: 30%
- **Tree Collapse**
  - Infrequent Users: 40%
  - Frequent Users: 20%
What information gathering features are used to explore ontologies?

Information Gathering Features

- Focus on Neighborhood
- Show Children
- Concept Details
- Show Hierarchy to Root
- Show Neighborhood
- Show Parents

Legend:
- Infrequent Users
- Frequent Users
What view customization is used to explore ontologies?

![Bar chart showing view customization usage by frequent and infrequent users. The chart includes categories such as Layouts, Label Arcs, Group Nodes, Ungroup Nodes, Filter Arcs, Hide Orphans, Expand Nodes, and Change Arc/Node Color. Infrequent Users are shown in blue, and Frequent Users are shown in red. The x-axis represents different actions, while the y-axis shows the percentage usage.]
# Tool research for navigation support

- **Diamond:** degree of interest model, can be applied to any tool
- **Search view in BioPortal**
- **FlexViz** (visualization in BioPortal)
DIaMOND—Degree of Interest Modeling for Ontology Navigation and Development

**Motivation:**
Navigating ontologies can be **tedious**...

Users often don’t know where to **start** when navigating an unfamiliar ontology

http://www.thechiselgroup.org/diamond
DIaMOND -- Approach

- Applies principles of **attention-reactive** interfaces
  - Mechanism to calculate user’s degree of interest (DOI)
  - Dynamic display of information using the DOI

- Goals
  - Draw user’s **attention** to interesting elements
  - Reduce navigation **overhead**
Highlighting and Filtering in the Class Browser (integration with Protégé)
Prototype search UI -- Demo
## Search UI features

- Searches across all ontologies, or optionally can **filter** by one or more ontologies.
- Searches are **saved** to be run again.
- Shows the most **frequent** search queries as well as most **recent** search queries.
- Search **results** are **sortable**, **filterable**, and now have the option of using **Degree of Interest** data highlighting the results and/or filter the results.
- Ontologies list also has the Degree Of Interest highlighting and filtering options.
Diamond applied to Search Views

Matching Terms

<table>
<thead>
<tr>
<th>Term Name</th>
<th>Ontology</th>
<th>Found In</th>
<th>Details</th>
<th>Visualize</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melanoma</td>
<td>Cell line ontology</td>
<td>Preferred Name</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melanoma</td>
<td>NCI Thesaurus</td>
<td>Preferred Name</td>
<td></td>
<td></td>
</tr>
<tr>
<td>melanoma</td>
<td>Human disease</td>
<td>Preferred Name</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melanoma</td>
<td>Gene</td>
<td>Preferred Name</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melanoma</td>
<td>MedlinePlus Health Topics</td>
<td>Preferred Name</td>
<td></td>
<td></td>
</tr>
<tr>
<td>melanoma</td>
<td>HL7 Version 1.0</td>
<td>Preferred Name</td>
<td></td>
<td></td>
</tr>
<tr>
<td>melanoma</td>
<td>HL7 Version 2.x</td>
<td>Preferred Name</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Discussion on Search

• Is this degree of interest concept useful in the search window?
FlexViz -- Demo
Recent updates

- Ontology **metrics** window
- Ontology **tree** synchronization with **graph** view
- **Export** graph as an image or an xml file, can be emailed as an attachment
- New **layouts** - ForceDirectedLayout, SpringLayout, and IndentedTreeLayout
- **FlexViz widget** (e.g. embed within another website)
- Many other small but important **usability** changes
- What next? Tell us 😊
MAPPING
CogZ

Cognitive Support and Visualization for Human-Guided Mapping Systems
Ontology alignment

- Very difficult cognitive task

- The user must:
  - Make **decisions** about mapping candidates
  - Supply **custom mappings** that were missed
  - Understand the **domains** and **structure** of both ontologies
  - **Remember** decisions that were made

- Cognitive support framework informed by user studies, a survey and an observational study
Working with mappings on the web

• Current view of mappings on BioPortal

Many ontologies in BioPortal have terms with similar meanings (e.g., there is a term for “Heart” in several ontologies). BioPortal users and NCBO researchers have contributed mappings between related terms from different ontologies. Use this page to explore mappings between ontologies that you are interested in. You will also see the mappings when you browse individual ontologies.

<table>
<thead>
<tr>
<th>ONTOLOGY MAPPED TO</th>
<th>MAPPING COUNT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mouse adult gross anatomy</td>
<td>3</td>
</tr>
<tr>
<td>Cell type</td>
<td>7</td>
</tr>
<tr>
<td>Chemical entities of biological interest</td>
<td>108</td>
</tr>
<tr>
<td>Drosophila discoides anatomy</td>
<td>1</td>
</tr>
<tr>
<td>Human disease</td>
<td>6</td>
</tr>
<tr>
<td>Evidence codes</td>
<td>4</td>
</tr>
<tr>
<td>Drosophila gross anatomy</td>
<td>39</td>
</tr>
<tr>
<td>FlyBase Controlled Vocabulary</td>
<td>4</td>
</tr>
<tr>
<td>Fungal gross anatomy</td>
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Overview of ontologies and their mappings:
Mapping Explorer (2)

Shows 1-1 mappings:
Web based mapping views – ongoing questions…

- Do we want to be able to edit mappings on the web?
- How else should we visualize the mappings? How to select the ontologies for an overview?
- Are neighbourhood views desired?
- What other features of CogZ make sense to bring to the web?
VISUALIZATION AS A SERVICE
Visualization as a Service: Project Goals

- Enable the **flexible visual exploration and analysis** of biomedical ontologies and data
- **Support collaboration** in visual exploration and analysis of biomedical ontologies and data
- Enable **presentation** of analysis artifacts on the web
Visual analytics over the web...

- For example, IBM ManyEyes... using it for visualizing clinical trial data
Our Approach: Bio-Mixer

Biomedical Information & Ontology – Mashup & Integrated eXploration EnviRonment
Bio-Mixer Development

- Jan - May 2009
  Explored different technologies (IBM Lotus Mashups, Ruby on Rails, dojo toolkit, GWT)
- May 2009 – present
  Implementation of mashup environment in GWT
BioMixer in action (1)
BioMixer in action (2)
BioMixer Demo

Current features:

- Multiple views
- Multiple ontologies
- NCBO Search
- Explore concept mappings
- Creating sets
- Highlighting
- Previews and highlighting
- Undo redo
- Store workspaces
BioMixer – Proposed Features
Map, timeline and list views

Map, timeline and list views

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Export widget #1 (mock-up)
Export widget #2 (mock-up)
Share workspace (mock-up)
Note taking (mock up)
BioMixer -- Roadmap

- **2010**
  - Implementing outlined functionality

- **2011**
  - Exploring further improvements and opportunities

- Need help developing use cases and trying out our ideas (DBPs?)
- Email: mstorey@uvic.ca
Summary

- Dealing with information overload and providing views that are useful (FlexVis and BioPortal Search, Diamond)

- **CogZ**: Cognitive support for ontology alignment and for visualizing mappings in BioPortal (moving towards the web – Mapping Explorer)

- Visualization as a Service: **BioMixer**
Future research directions and themes

- **Web based visualizations** for a diverse and evolving user base and task set
  - Customizable and flexible views
  - Visualization as a service (mashups)

- **Cognitive support** rather than visualization
  - Ontologies, annotations and mappings
  - Search
  - Concept comparison (local, global and historical information)
  - Meta-analyses
Future research directions and themes cont.

- **Collaborative aspects**
  - Humans and software agents
  - Ontologies and visualizations as “boundary objects”
  - A collaborative space for ontology exploration?

*Boundary object* refers to an object that serves as an interface between different communities of practice. Boundary objects are shared by several different communities but viewed or used differently by each of them, e.g. Classification systems. (Bowker & Star, 2000).
Acknowledgements:

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BioPortal team!
References and websites

Reference:

Websites:
- Diamond: [http://thechiselgroup.org/diamond](http://thechiselgroup.org/diamond)
- FlexViz: [http://www.thechiselgroup.org/flexviz](http://www.thechiselgroup.org/flexviz)
- CogZ website: [http://www.thechiselgroup.org/cogz](http://www.thechiselgroup.org/cogz)