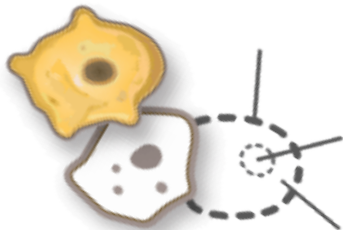
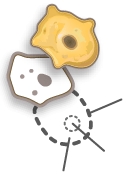


NCBO Technology Overview

Trish Whetzel
Outreach Coordinator

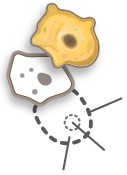


THE NATIONAL CENTER FOR
BIOMEDICAL ONTOLOGY



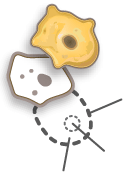
Links of Interest

- http://www.bioontology.org/wiki/index.php/NCBO_Web_Services_and_the_Development_of_Semantic_Applications



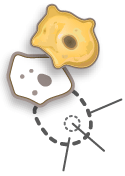
Outline

- Learning Objectives
- REST Web services
- BioPortal
- NCBO Web Services
- BioPortal SPARQL Endpoint



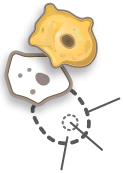
Learning Objectives

- Learn what Web services are available from NCBO
- Learn how to programmatically use these Web services
- Learn how to combine these Web services to perform tasks



REST Web Services

- Accessed via HTTP
 - <http://rest.bioontology.org/{parameters}>
- Each unique URL is a representation of some object
- Operations include GET, POST, PUT, DELETE
- Lightweight, easy to build



BioPortal Browse Search Projects Annotate All Mappings All Resources Alpha Sign In Register Help/About Send Feedback

Welcome to the NCBO BioPortal

Use BioPortal to access and share ontologies that are actively used in biomedical communities. You can search for terms in ontologies (try typing "Melanoma" in the "Search all ontologies" box in the left column), browse a list of ontologies in BioPortal (type "NCI Thesaurus" in the "Find an ontology" box in the middle column), search biomedical resources that we automatically annotated with ontology terms (try typing "Melanoma" in the "Search resources" box in the right column). You can create ontology-based annotations for your own text, link your own project that uses ontologies to the description of those ontologies, find and create relations between terms in different ontologies, review and comment on ontologies and their components as you browse them. Sign in to BioPortal to submit a new ontology or ontology-based project, provide comments on ontologies or add ontology mappings.

Search all ontologies

[Advanced Search](#)

Find an ontology

[Browse Ontologies >](#)

Search resources

[Advanced Resource Search](#)

Most Viewed Ontologies (May, 2010)

Ontology	Views
NCBI organismal classification	1612
NCI Thesaurus	1567
SNOMED Clinical Terms	1170
RadLex	880
Foundational Model of Anatomy	804

Latest Notes

[relationship with Smoking Behavior \(NCI Thesaurus\)](#) 19 days ago by [discourtesy](#)
Seems odd that Tobacco Use as a term is disconnected from the term Smoking Behavior. Although To...

[terms to add under technique \(NanoParticle Ontology\)](#) 24 days ago by [dq178](#)
electron microscope analysis environmental transmission electron microscopy spectrophotometry etc...

[terms to add under instrument \(NanoParticle](#)

Latest Mappings

[JERMOntology:BioMaterial \(SysMO-JERM\) => BioMaterial \(MGED Ontology\)](#)
BioPortal UID:07110 kwolstencroft

[BioMaterial \(MGED Ontology\) => JERMOntology:BioMaterial \(SysMO-JERM\)](#)
BioPortal UID:07110 kwolstencroft

[JERMOntology:ReplicateType \(SysMO-JERM\) => ReplicateDescriptionType \(MGED Ontology\)](#)
BioPortal UID:07110 kwolstencroft

[ReplicateDescriptionType \(MGED Ontology\) => JERMOntology:ReplicateType \(SysMO-JERM\)](#)
BioPortal UID:07110 kwolstencroft

User Interface

```
use strict;
use LWP::UserAgent;
use URI::Escape;
use List::Util qw{first max maxstr min minstr reduce shuffle sum};

$|=1;

# Read in text to annotate, this is just a dump of the _EF table for any resource in OBR:
my $fTestSet;
open( PUBMED, "C:/All_current_work/NCBO/Optra/QC/Pubmed/Pubmed_EF.txt" or die "Can't open file\n";
open( PUBMED, "../Pubmed_EF.txt" or die "Can't open input file\n";
while <PUBMED>{
    chop $_;
    my ($elementID, $localElementID, $dictionaryID, $SNM3_title, $SNM3_abstract, $SNM3_key);
    $fTestSet = split ' ' $_;
    $fTestSet{$localElementID} = "$SNM3_title $SNM3_abstract";
}
print "Done reading input file\n";
print scalar keys %fTestSet, " entries in file\n";

# create a user agent
my $ua = new LWP::UserAgent;
my $time = time;
my $sofTime = 0;
my $sofWords = 0;
# make request to the desired URL
# http://ncbo-obs-stage1.stanford.edu:8080/obs_hibernata/annotator
# http://ncbo-obs-prod1.stanford.edu:8080/obs_hibernata/annotator
my $req = new HTTP::Request 'POST' => "http://rest.bioontology.org/obs_hibernata/annotator";
$req->content_type('application/x-www-form-urlencoded');

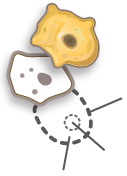
my $numTests = 0;
my @fTestText = shuffle (sort keys %fTestSet);
foreach my $k (@fTestText){
    # set parameters
    my $text = $fTestSet{$k};
    $req->content_type('application/x-www-form-urlencoded');
```

Code

```
<-access>
<-data>
<-list>
  <-ontologyBean>
    <id>40133</id>
    <ontologyId>1200</ontologyId>
    <displayName>ABA Adult Mouse Brain</displayName>
    <description>Allen Brain Atlas P56 Mouse Ontology</description>
    <abbreviation>ABA</abbreviation>
    <format>OWL</format>
    <internalVersionNumber>1</internalVersionNumber>
    <versionNumber>1.0</versionNumber>
    <contactName>Allen Institute for Brain Science</contactName>
    <contactEmail>chibba@alleninstitute.org</contactEmail>
    <statusId>3</statusId>
  <-categoryId>
    <id>2817</id>
    </categoryId>
    <isFoundry>0</isFoundry>
    <dateCreated class="sql-timestamp">2009-06-25 15:52:15.0</dateCreated>
  <-ontologyBean>
    <id>40223</id>
    <ontologyId>1099</ontologyId>
    <displayName>African Traditional Medicine</displayName>
    </description>
    <description>
      African Traditional Medicine Ontology (ATMO) describes the actors' function (healer, fe
      roles and the disease consideration.
    </description>
    <abbreviation>ATMO</abbreviation>
    <format>OBO</format>
```

Browser

Web Services



Outline

- REST Web services
- **BioPortal**
- NCBO Web Services
- BioPortal SPARQL Endpoint

Welcome to BioPortal! For help using BioPortal, click on this icon: ?

Search all ontologies

Enter term, e.g. Melanoma

Search

[Advanced Search](#)

Find an ontology

Enter ontology name, e.g. NCI Thesaurus

Explore

[Browse Ontologies >](#)

Search resources

Enter a term, e.g. Melanoma

Search

[Advanced Resource Search](#)

Most Viewed Ontologies (October, 2011)

Ontology	Views
National Drug File	7975
SNOMED Clinical Terms	3977
MedDRA	3293
Medical Subject Headings	1620
NCI Thesaurus	1227

Latest Notes

[RE: what's the difference between this note and notes on mappings? \(Biomedical Resource Ontology\)](#) about 1 month ago by whetzel
The Term Notes refer to comments or actions requested on Terms in the ontology. The Mapping Notes...

[what's the difference between this note and notes on mappings? \(Biomedical Resource Ontology\)](#) 2 months ago by imposimon
Would you guys please answer this for me?

[Re: Why have you deprecated this? \(Biomedical Resource Ontology\)](#) 4 months ago by whetzel
This term was deprecated because there was a typo in the term name.

[Why have you deprecated this? \(Biomedical](#)

Latest Mappings

[b117. Intellectual functions \(International Classification of Functioning, Disability and Health \(ICF\)\) => Ability to perform cognitive activity \(SNOMED Clinical Terms\)](#)
11/18/11 samsontu

[b110. Consciousness functions \(International Classification of Functioning, Disability and Health \(ICF\)\) => Consciousness related finding \(SNOMED Clinical Terms\)](#)
11/18/11 samsontu

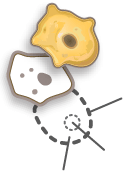
[b114. Orientation functions \(International Classification of Functioning, Disability and Health \(ICF\)\) => Orientation \(SNOMED Clinical Terms\)](#)
11/18/11 samsontu

[b1109. Consciousness functions, unspecified \(International Classification of Functioning, Disability and Health \(ICF\)\) => Consciousness](#)

Statistics

Ontologies	294
Terms	5,670,579

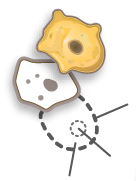
<http://bioportal.bioontology.org>



Outline

- REST Web services
- BioPortal
- **NCBO Web Services**
- BioPortal SPARQL Endpoint

<http://rest.bioontology.org>



Ontology Services

Views

- Search
- Traverse
- Comment
- Download

Mapping Services

- Create
- Upload
- Download

Widgets

- Tree-view
- Auto-complete
- Graph-view

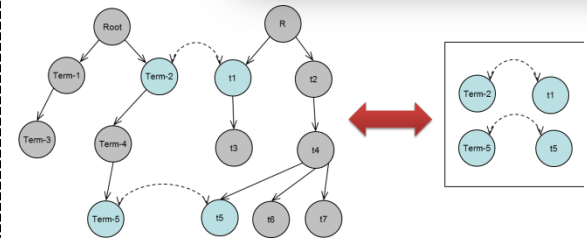
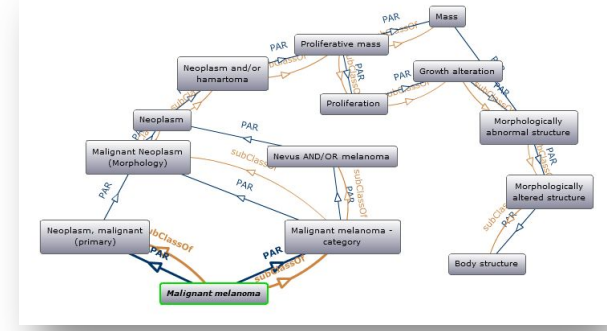
Annotation

Term recognition

Data Access

Fetch "data" annotated with a given term

<http://biportal.bioontology.org>

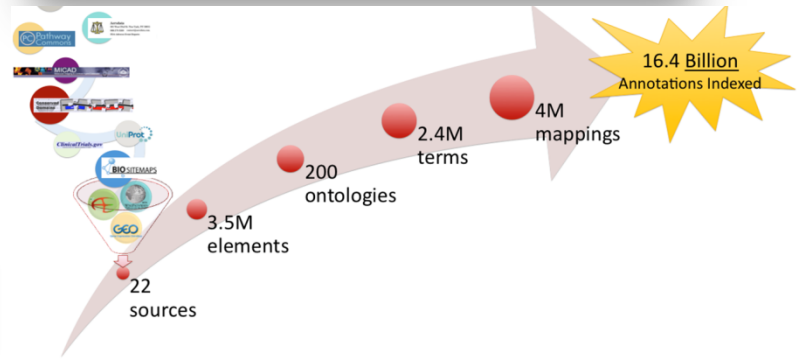


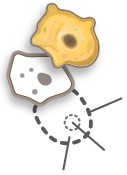
Jump To:

Legend

- Malignant melanoma (synonym)
- Amelanotic melanoma (preferred name)
- Excision of melanoma (preferred name)
- Melanoma in situ (preferred name)
- Melanoma vaccine (preferred name)

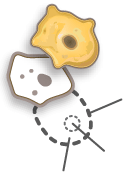
Expression, Expression of bladder, bladder, smooth, bladder muscle, muscle, smooth muscle, cells, mechanical, mechanical stimulation, stimulation, Chronic, results, bladder overdistension, associated, associated with, with, loss, genes, altered





ONTOLOGY WEB SERVICES

Accessing, browsing, searching and traversing ontologies in *Your* application



Ontology Web Services

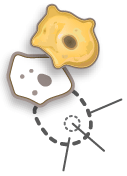
- List All Ontologies
 - List all ontologies in BioPortal
 - Documentation: <http://bit.ly/sxL2Qi>
 - GoogleDoc Excel example:
<http://bit.ly/ncbo-list-all-ontologies>

One ontology id
has many ontology
version ids

```
- <success>
  <accessedResource>/bioportal/ontologies</accessedResource>
  <accessDate>2011-12-04 22:01:39.603 PST</accessDate>
- <data>
  - <list>
    + <ontologyBean></ontologyBean>
    + <ontologyBean></ontologyBean>
    + <ontologyBean></ontologyBean>
    - <ontologyBean>
      <id>44776</id>
      <ontologyId>1351</ontologyId>
      - <virtualViewIds>
        <int>1420</int>
        <int>1456</int>
      </virtualViewIds>
      <internalVersionNumber>3</internalVersionNumber>
      - <userIds>
        <int>38134</int>
      </userIds>
      <versionNumber>2011_2010_08_30</versionNumber>
      <isRemote>0</isRemote>
      <statusId>3</statusId>
      <dateCreated>2010-11-09 11:16:42.0 PST</dateCreated>
      <dateReleased>2010-08-30 00:00:00.0 PDT</dateReleased>
      <isManual>1</isManual>
      <displayLabel>Medical Subject Headings</displayLabel>
      - <description>
        Medical Subject Headings (MeSH);National Library of Medicine;February, 2009;Bethesda, MD;ENG
      </description>
      <abbreviation>MSH</abbreviation>
      <format>RRF</format>
```

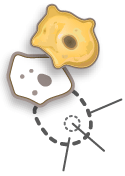
Ontology version id

Ontology id



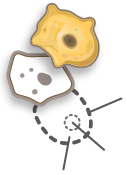
Ontology Web Services cont.

- Search
 - Search by term or term identifier across all ontologies in BioPortal
- Documentation: <http://bit.ly/tMDkr6>
- Example clients
 - Java: <http://bit.ly/ttTb1G>
 - Perl: <http://bit.ly/sPXC2X>



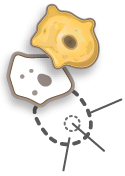
Ontology Web Services cont.

- Term
 - get details about a term including it's definition, synonyms, URI, super- and sub-classes, and other properties <http://bit.ly/teedbd>
- Hierarchy
 - get parent, children, and sibling terms <http://bit.ly/tPzm75>



NOTES WEB SERVICES

Propose new terms and comment on ontologies



Notes Web Service

- Add terms proposals and comments on ontology terms
- Documentation:
http://www.bioontology.org/wiki/index.php/Ontology_Notes

Notes

[Subscribe to notes emails](#)

Show entries

[Filtering Options >](#)

Search:

SUBJECT	AUTHOR	TYPE	TARGET	CREATED
New Term Proposal: Exercise Study Facility <small>archived</small>	Mette	New Term Proposal	Physiology Facility (Class)	06/15/2010

New Term Proposal: Exercise Study Facility archived

New Term Proposal submitted by [Mette](#) over 1 year ago on [Physiology Facility](#) in [Biomedical Resource Ontology](#)

PREFERRED NAME	Exercise Study Facility	PROVISIONAL ID	PARENT	http://bioontology.org/ontologies/BiomedicalResourceOntology.owl#Physiology_Facility
REASON FOR CHANGE	Physiology facility child	STATUS	CONTACT INFO	
SYNONYMS				
DEFINITION	A facility or core devoted to exercise studies			

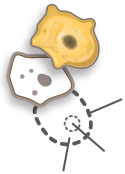
Responses

[hide all](#) | [show all](#)

RE: New Term Proposal: Exercise Study Facility by [whetzel](#) over 1 year ago

Can you expand on what an exercise study is?

reply



WebProtégé

The screenshot displays the WebProtégé interface with three main components highlighted by red boxes:

- 1** The **Classes** browser on the left, showing a hierarchical tree of classes. The **Physiology Facility** class is selected and highlighted.
- 2** The **Properties for Physiology Facility** panel, which displays a table of properties and their values:

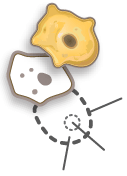
Property	Value
core:note	pending final vetting: Refine definition
core:prefLabel	Physiology Facility
core:editorialNote	pending final vetting: Refine definition
definition	A facility or core devoted to physiology (http://en.wikipedia.org/wiki/Physiology)
rdfs:label	Physiology Facility

- 3** The **BioPortal notes and proposals for Physiology Facility** panel, which displays a table of notes and proposals:

Subject	Date
New Term Proposal: Exercise Study Facility	Tue Jun 15 13:59:36 PDT 2010
RE: New Term Proposal: Sleep Study Facility	Tue Jun 15 22:18:05 PDT 2010
RE: New Term Proposal: Exercise Study Facility	Tue Jun 15 22:23:20 PDT 2010

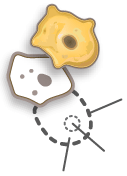
Below the table, there are input fields for **Author:** (Mette), **Date:** (06/15/10), **Type:** (ProposalForCreateEntity), and **Status:** (Under review). A dropdown menu is open, showing options: Under review, New term created, Rejected, and Linked to existing term.

<http://protegewiki.stanford.edu/wiki/WebProtege>



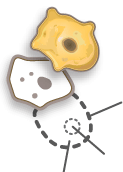
VIEWS

Custom subset of large ontologies



Views and Value Sets

- Users can submit their own derivatives of BioPortal ontologies
 - these which become first-class objects in BioPortal and can be used as all other Web services



Views in BioPortal

Views [Create new view](#)

[Expand All](#) | [Collapse All](#)

▸ **CORE Subset of SNOMED CT**

▸ **Neoplasm_breast_cancer**

▸ **Neoplasm_hamartoma**

▸ **SNOMED Anatomy**

▾ **SNOMED Clinical Findings**

- **Description:** The Clinical Finding subtree of SNOMED CT
- **Definition:** Class subtree of ClinicalFinding
- **Ontology ID:** 2018
- **Definition Language:** Manual

VERSION	BASE VERSION	CREATED	CREATED BY	ONTOLOGY FILE	DIFF FILE	VISIBILITY
1.2	2009_07_31	07/16/2010	Tania Tudorache, tudorache@stanford.edu	Download View		Public
1.1	2009_07_31	03/23/2010	Tania Tudorache, tudorache@stanford.edu	Download View		Public
1.0	2009_01_31	09/09/2009	Tania Tudorache, tudorache@stanford.edu	Download View		Public

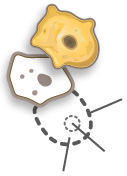
▸ **SNOMED Ethnic Group**

▸ **SNOMED Morphologically Abnormal Structure**

▸ **SNOMED Organism**

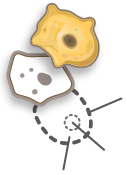
▸ **SNOMED Terminos Clinicos**

▸ **SNOMED Test Findings**



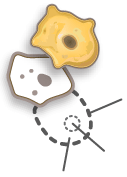
Views and Value Sets

- View Extraction Web service
 - Given a root node term, extracts all child terms
<http://bit.ly/uXeh2s>
- Access directly from Protégé via the BioPortal Import plugin
http://protegewiki.stanford.edu/wiki/BioPortal_Import_Plugin

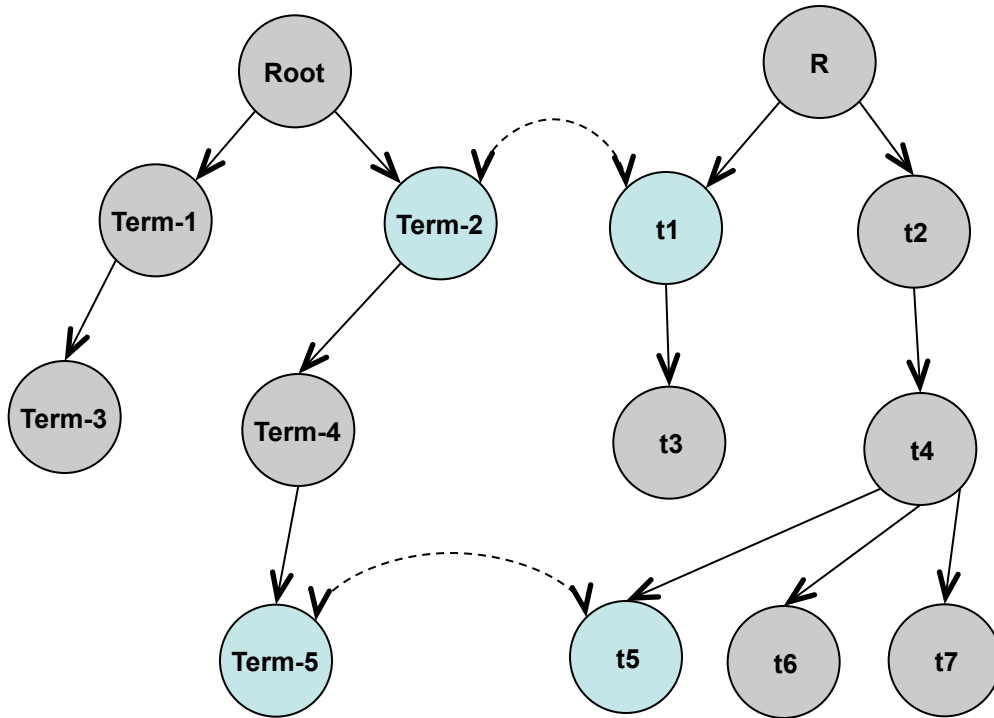


MAPPING WEB SERVICES

Using NCBO technology to integrate terminologies and ontologies

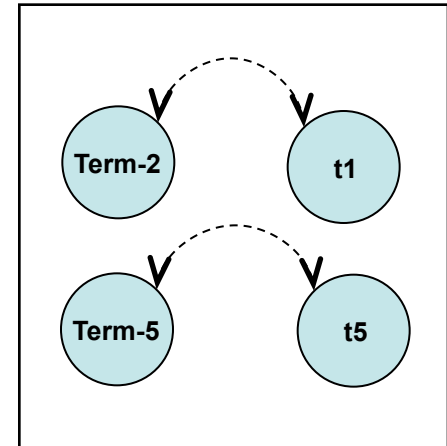


Mappings

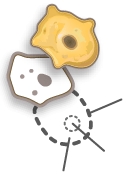


Ontology A

Ontology B

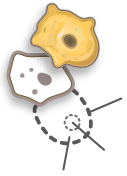


**Upload or Download
mapping subsets**



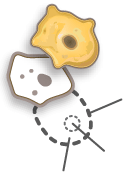
Mappings

- Mappings Web service
 - Documentation:
http://www.bioontology.org/wiki/index.php/BioPortal_Mappings_Service
- Functions
 - Get
 - Create/Upload
- Example Perl client to Get mappings:
<http://bit.ly/tDKPQd>



WIDGETS

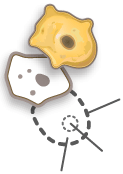
Using NCBO technology on your web pages



Widgets

- Form auto-complete – auto-complete function and can return term URI, term ID or term name
- Jump To – auto-complete function to select term and Jump To BioPortal to view term details
- Visualize widget – view the ontology structure and relations
- Tree widget – view the ontology tree

[Code for widgets is available on BioPortal](#)



Widgets

Example 1 (start typing the term name to get its full URI)

Example 2 (get the ID for a term)

Example 3 (get the preferred name for a term)

- melanocyte** (preferred name)
- MELAS syndrome** (preferred name)
- Drosophila **melanogaster** (preferred name)
- melanoma** (preferred name)
- Drosophila

Form auto-complete

Jump To:

- melanoma** (preferred name)
- cutaneous **melanoma** (preferred name)
- metastatic **melanoma** (preferred name)
- amelanotic skin **melanoma** (preferred name)

Example 1
 Results provided by [NCBO BioPortal](#)

Jump To

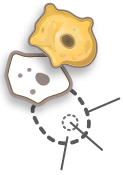
Get RSS feed for changes in Experimental Factor Ontology

[Ontology added](#) 11/05/09
Ontology Experimental Factor Ontology version 1.7 was added to the repository

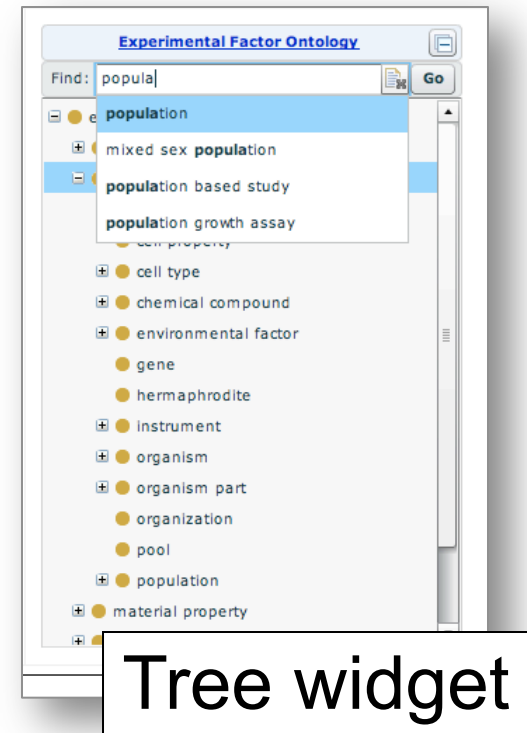
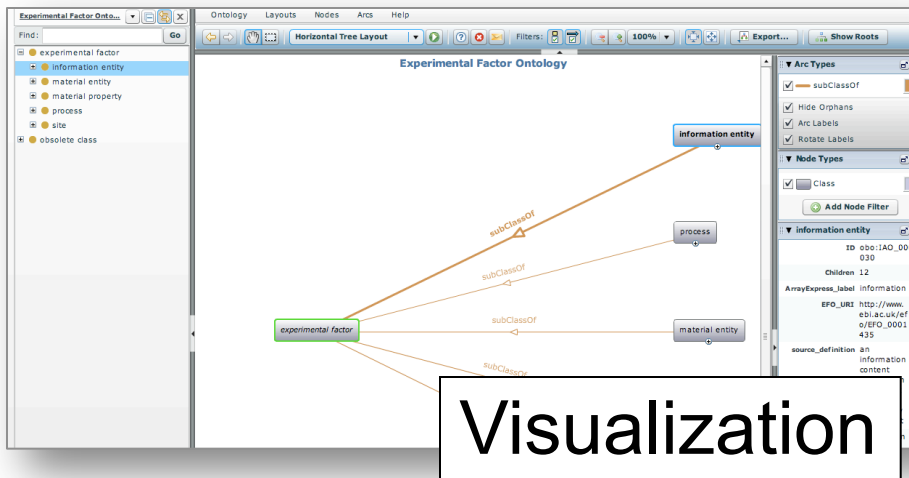
[Ontology added](#) 10/07/09
Ontology Experimental Factor Ontology

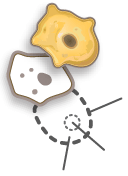
BioPortal

RSS feed

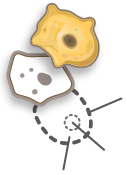


Widgets



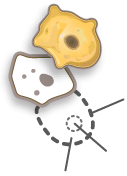


Break



ANNOTATOR WEB SERVICE

Using Ontologies to Annotate *Your* Data



Annotator: The Basic Idea

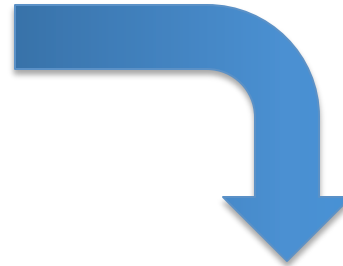
- Tag textual metadata with ontology terms

NCBI GEO - Accession Display [?](#)
GEO Publications | [FAQ](#) | [MIAME](#) | [Email GEO](#)
Not logged in | [Login](#) [?](#)

Scope: Format: Amount: GEO accession:

Series GSE12391 [Query DataSets for GSE12391](#)

Status Public on Sep 30, 2009
Title Melanoma: comparison between common nevi, radial/vertical growth phase melanoma, metastases and dysplastic nevi
Organism [Homo sapiens](#)
Experiment type Expression profiling by array
Summary **Despite malignant cutaneous melanoma is relatively rare compared to other skin cancers, it is still responsible for 80% of all skin cancer-related deaths. To identify molecular signatures of melanoma progression, excisional biopsies from 18 common melanocytic nevi (CMN), 8 primary radial growth phase melanomas (RGPM), 15 primary vertical growth phase melanomas (VGPM) and 5 melanoma metastases (MTS) were profiled using whole genome oligo-microarrays. Differentially expressed genes for each progression step were identified, and validation of selected transcripts by qRT-PCR was performed on an independent cohort of fixed samples. The comparison between CMN and RGPM showed an enrichment of Gene Ontology (GO) terms related to inter and intra-cellular junctions, whereas the transition from RGPM to VGPM was characterized by the deregulation of WNT3, MAPK and AKT pathways. In this step, enrichment analysis underlined the alteration of biological processes linked to apoptosis. Upregulation of genes involved into DNA double-strand breaks repair and downregulation of cellular adhesion genes were observed in**



Melanoma Genes Malignant melanoma

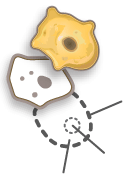
[growth & development](#) [Structural gene](#) [Growth](#) [Skin](#) [Skin](#) [Skin Neoplasms](#)

[Nevus](#) [Neoplasms](#) [Abnormal or excess nevi](#) [DNA](#) [Oncogenes](#) [Genome](#) [Biological Processes](#) [Genome](#)

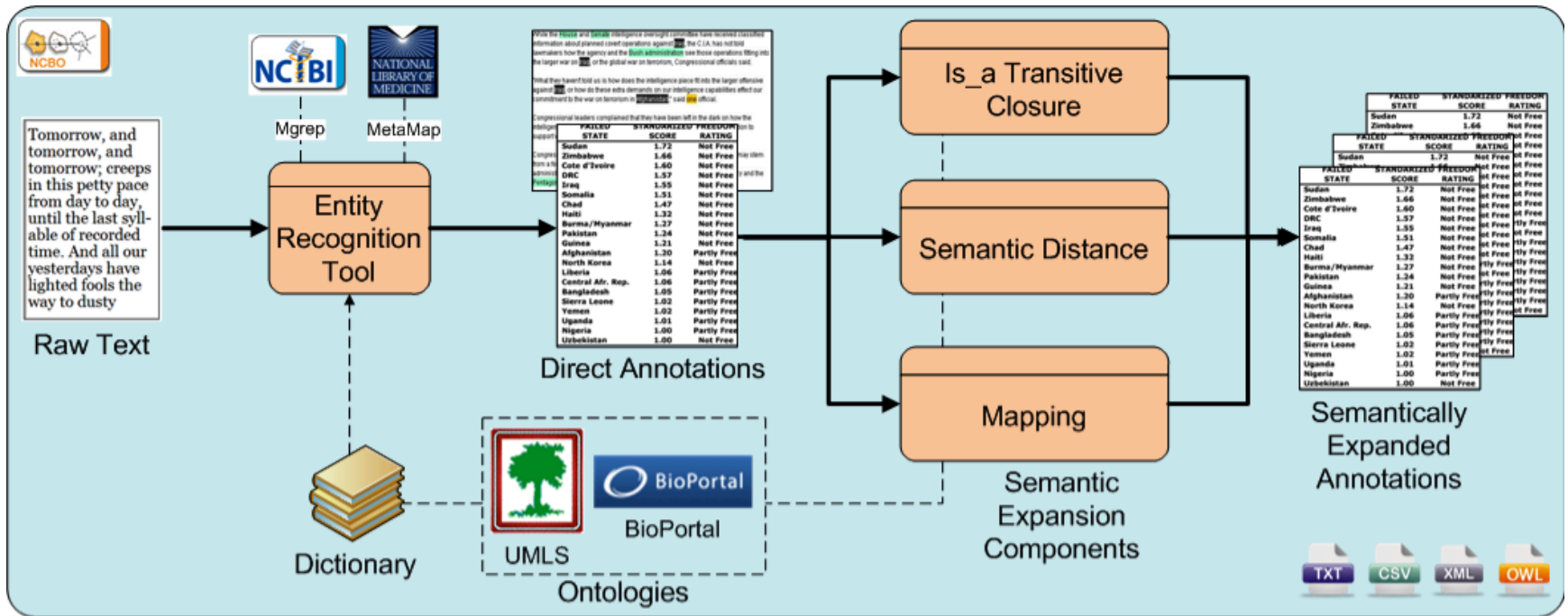
[Risk](#) [Gene Expression](#) [Overall](#) [Heterogeneous](#) [analysis](#) [Intermediate](#) [Vertical](#) [Apoptosis](#) [Biopsy](#)

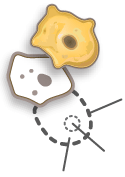
[Gene Expression Profiling](#) [DNA Mismatch Repair](#) [Neoplasm Metastasis](#) [Nevus, Pigmented](#) [Down-Regulation](#) [Up-Regulation](#)

[Deoxyribonucleic acid](#) [Pigmented nevi](#) [Circumpennate](#) [Polymerase Chain Reaction](#) [Dysplastic Nevus Syndrome](#) [Family](#)



Annotator Workflow





Annotator Web Service

- Tag free text with ontology terms

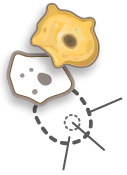
- Documentation:

http://www.bioontology.org/wiki/index.php/Annotator_Web_service

- Example clients:

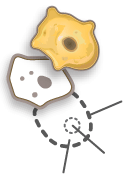
- Perl: <http://bit.ly/vKYpCP>

- Java: <http://bit.ly/rRFoKd>

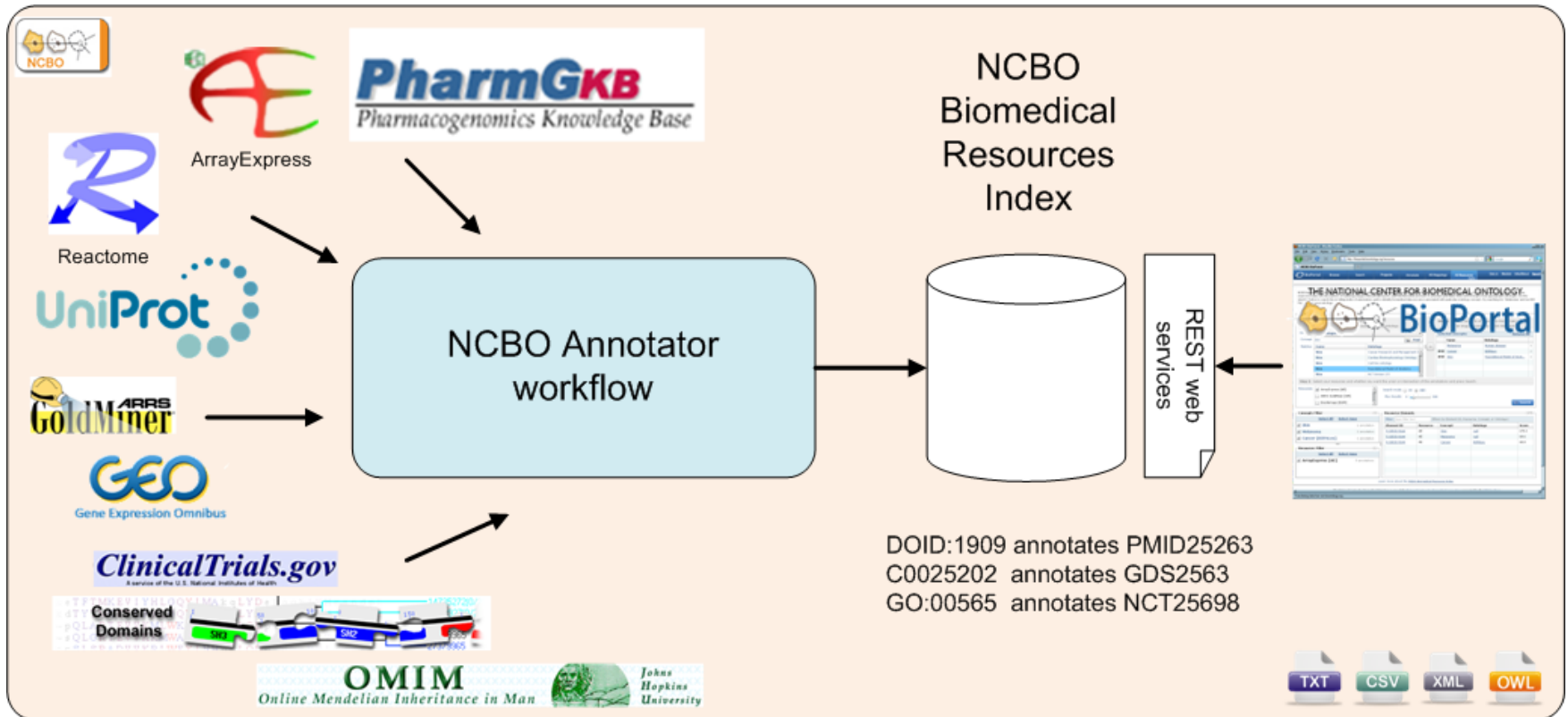


DATA SERVICE

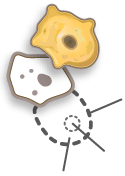
Using Ontologies to Access Public Data



Resource Index: The Basic Idea



- The index can be used for
 - Search
 - Data mining



Resources index: Example

Gene Expression Omnibus

Eutils Web Service API

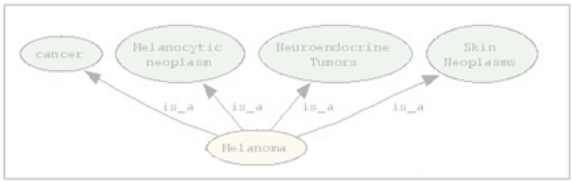
e.g., element GDS1989

Accessing resource elements

```
<title>
  Melanoma progression
</title>

<description>
  Analysis of tissue specimens representing benign nevus, atypical nevus, melanoma in situ, vertical growth phase (VGP) melanoma, and metastatic growth phase (MGP) melanoma. Results identify expression signatures that distinguish benign and atypical nevi and melanomas in situ from VGPs and MGPs.
</description>
```

Concept recognition



172 closure annotations

Examples:
Cancer, concept (DOID:162) in ontology *Human disease*
Skin Neoplasms, concept (DOID:3165) in ontology *Human disease*

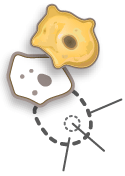
Semantic expansion

```
<title>
  Melanoma progression
</title>

<description>
  Analysis of tissue specimens representing benign nevus, atypical nevus, melanoma in situ, vertical growth phase (VGP) melanoma, and metastatic growth phase (MGP) melanoma. Results identify expression signatures that distinguish benign and atypical nevi and melanomas in situ from VGPs and MGPs.
</description>
```

23 direct annotations
 (4 title, 19 description)

Example:
Melanoma, concept (DOID:1909) in ontology *Human disease*.



Data Access

- Resource Index Web service
 - Documentation:
http://www.bioontology.org/wiki/index.php/Resource_Index