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Semantic technologies improving the recall and precision of the Mercury metadata search engine

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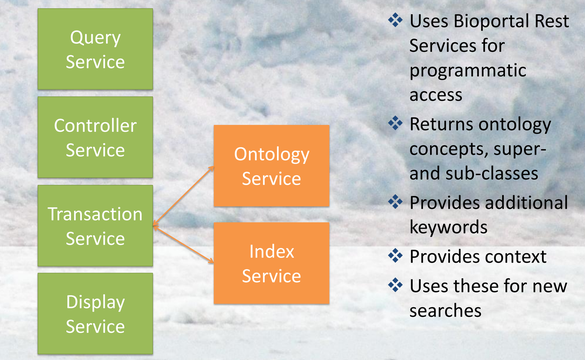
Two Relevance Metrics from Information Retrieval

$$\text{Recall} = \frac{\text{Relevant Documents} \cap \text{Retrieved Documents}}{\text{Relevant Documents}}$$

$$\text{Precision} = \frac{\text{Relevant Documents} \cap \text{Retrieved Documents}}{\text{Retrieved Documents}}$$

- 100% recall means all relevant documents were retrieved, but maybe also many non-relevant ones.
- 100% precision means all retrieved documents were relevant, but where relevant documents not retrieved?



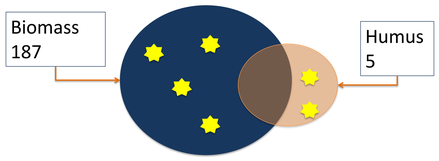
- Uses Bioportal Rest Services for programmatic access
- Returns ontology concepts, super- and sub-classes
- Provides additional keywords
- Provides context
- Uses these for new searches

Architecture Diagram

CURRENT DATA DISCOVERY

- Each dataset is represented by a metadata XML document
- Data discovery is based on the content of several XML elements
- Results are presented as facetted searches
- Mercury supports FGDC, Dublin and Darwin cores, Ecological Mark-up Language and ISO 19115
- The ORNL DAAC holds over 100,000 metadata records from several data providers
- Over 1000 datasets focus on biogeochemical dynamics, ecological data, and environmental processes, accounting for 2 TB
- Also holds MODIS land product subsets, accounting for 60 TB

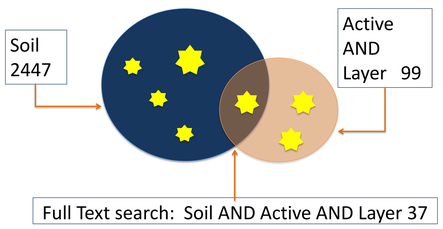
Why improve Recall?



Full Text search: Biomass OR Humus 192

Humus is a type of Biomass:
5 additional datasets are found
Humus is contained in their metadata but NOT Biomass

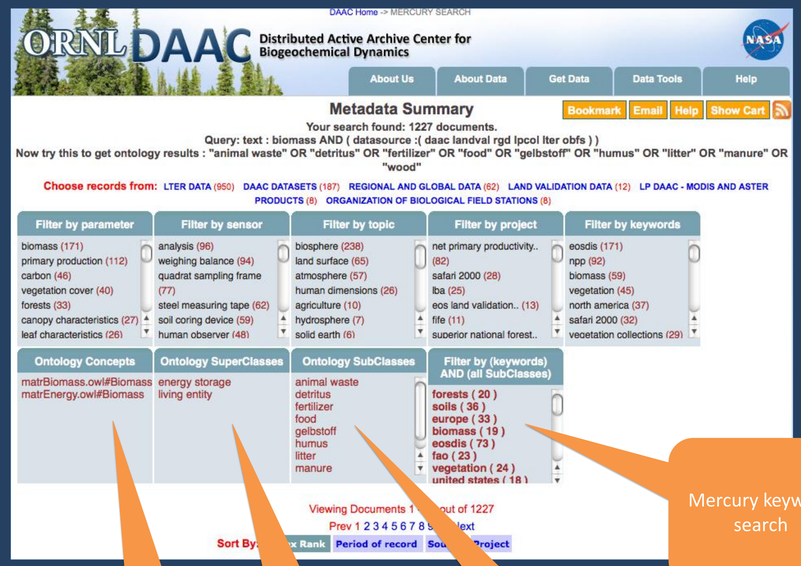
Why improve precision?



Full Text search: Soil AND Active AND Layer 37

Too many facets can be confusing
Active Layer DOES NOT appear as a facet
The user must enter a new query to find the 37 datasets

Our approach: re-use, interoperability, integration

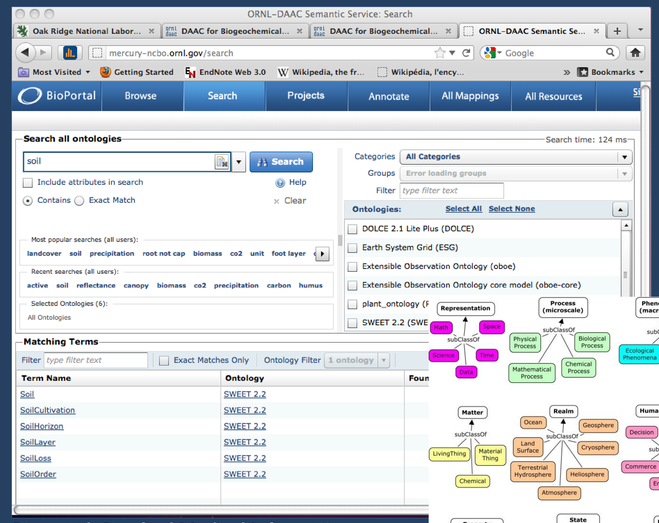


Mercury keyword search

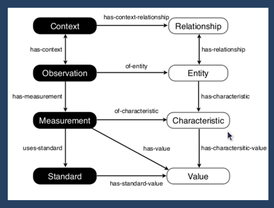
Concepts acquire context: biomass as Material or biomass as Energy

Super-classes have different properties

Additional search terms



Bioportal, Stanford Medical Informatics



OBOE: Extensible Observation Ontology, UCSB

SWEET: Semantic Web for Earth and Environmental Ontologies, JPL

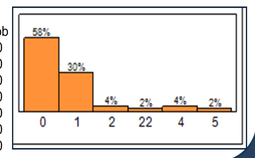
Plant Ontology PO Consortium

Discussion

- SWEET provides a good basis
- Needs to be further specified for this data center requirements
- Ontology concepts and terms match no keywords in the Mercury index
- The current display will not scale to more relationships.
- Many ontologies provide only a few relationships

Matching the top 50 keywords in Mercury to ontology terms

Frequencies n=50		
Level	Count	Prob
0	29	0.58000
1	15	0.30000
2	2	0.04000
22	1	0.02000
4	2	0.04000
5	1	0.02000
Total	50	1.00000



58% of top 50 keywords have no match: adding semantics to a keyword index can never replace annotations of the source datasets.

Rethink the approach of metadata capture to include ontology objects
Add ontologies and/or provide SWEET extensions
Dynamically driven display for improved clarity and comprehension

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