User Centered and Ontology Based Information Retrieval System for Life Sciences

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Context and objectives

Ontology based information retrieval

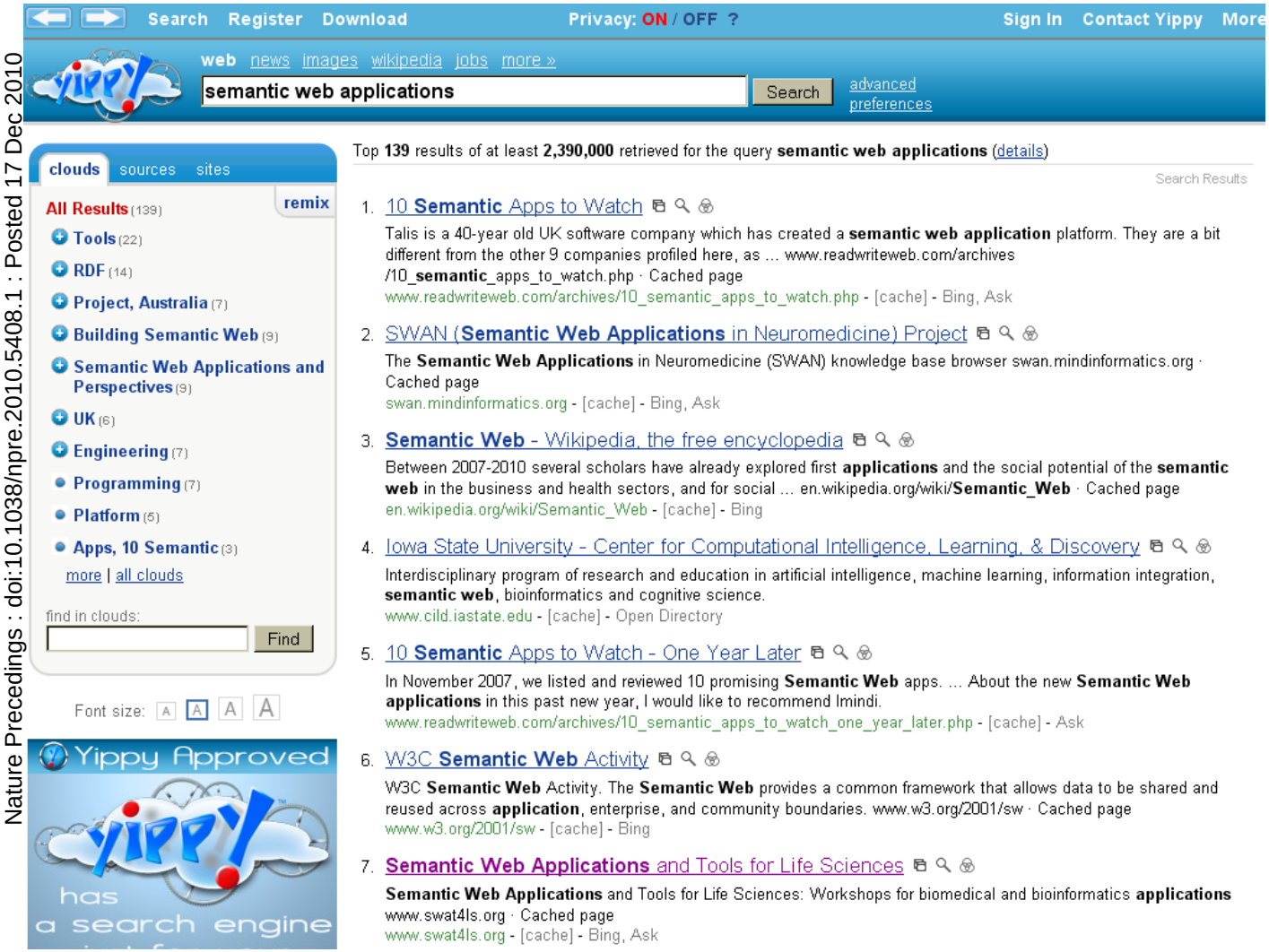
Relevance calculus between a document index and a query

- *Similarity between two concepts*
- *Relevance of a document with respect to a concept*
- *Relevance of a document with respect to a query*

Results visualization

Conclusion et perspectives

Context: *usual information retrieval engine*



Boolean search

+Results are easy to understand

-Exact terms matching

-Number of results

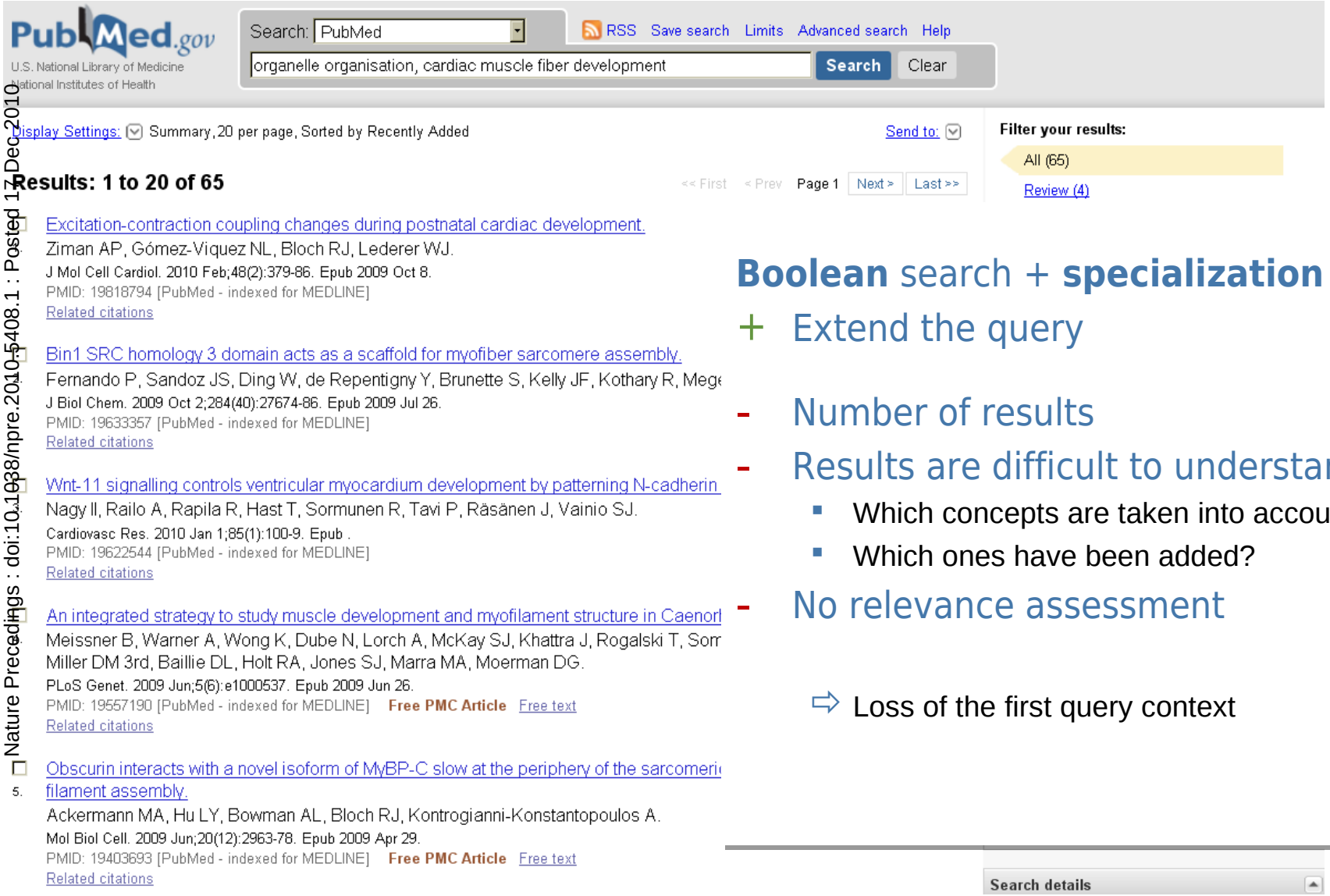
-Rough measurement: "match" or "does not match"

-Limited interaction

-Aggregating operators are not used (AND, OR...)

⇨ Hard to grasp even with clustering

Context: *information retrieval based on a concepts hierarchy*



Boolean search + **specialization**

\+ Extend the query

\- Number of results

\- Results are difficult to understand

- Which concepts are taken into account?
- Which ones have been added?

\- No relevance assessment

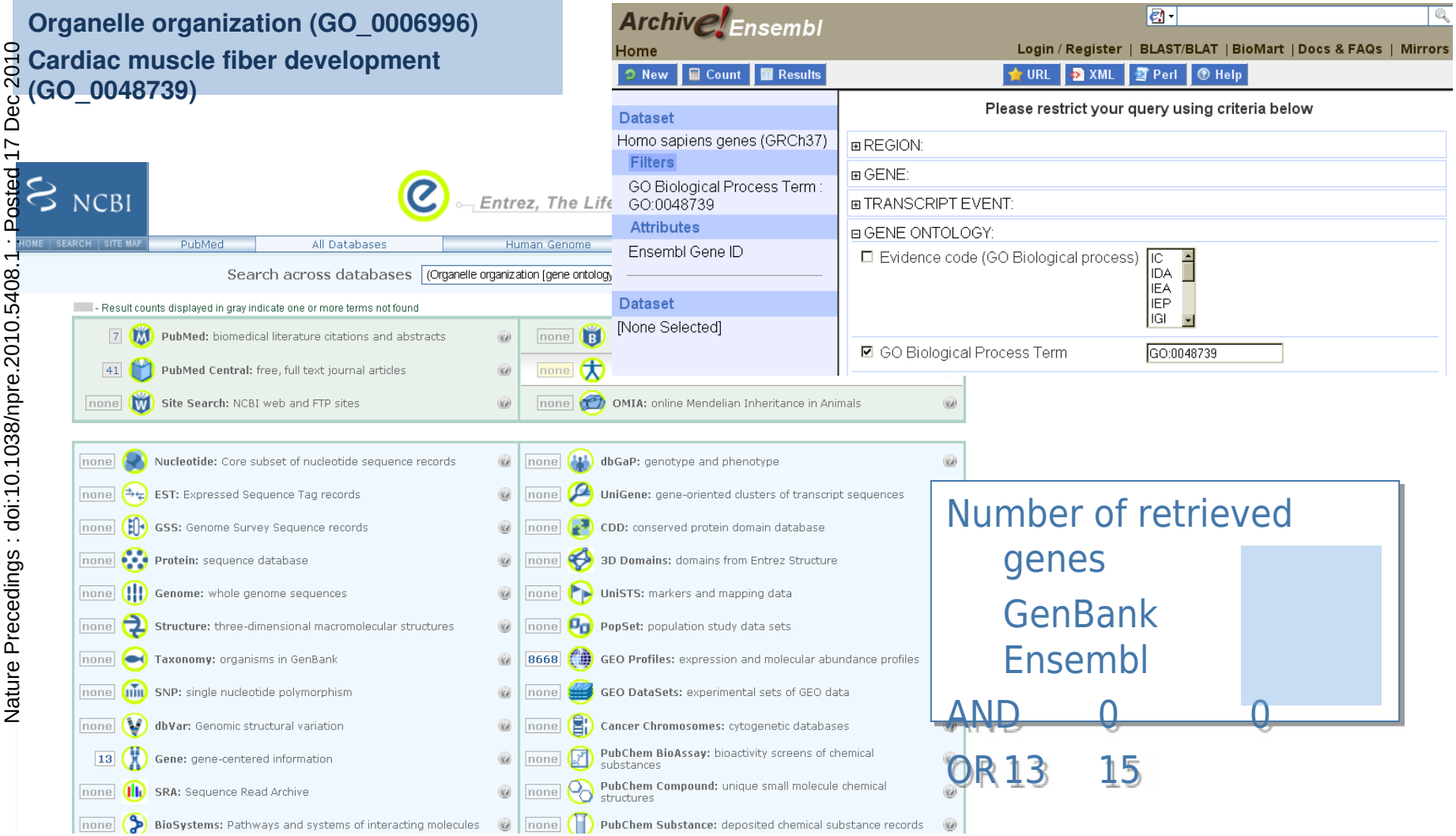
⇨ Loss of the first query context

Context: *information retrieval using ontologies*

?

Organelle organization (GO_0006996)

Cardiac muscle fiber development (GO_0048739)



Number of retrieved genes	GenBank	Ensembl
AND	0	0
OR	13	15

Take better benefits of ontologies during the information retrieval process (indexing/query matching)

- Expand the query if necessary
- Measure document/query adequacy by identifying added concepts

Favor the overall results' grasp by the user

- Explain why a document has been selected
- Give an overall vision of results
- If a selected document is not relevant, identify why in order to reformulate the query conveniently

Taking user preferences into account

⇨ Favor interactions and iterative querying process

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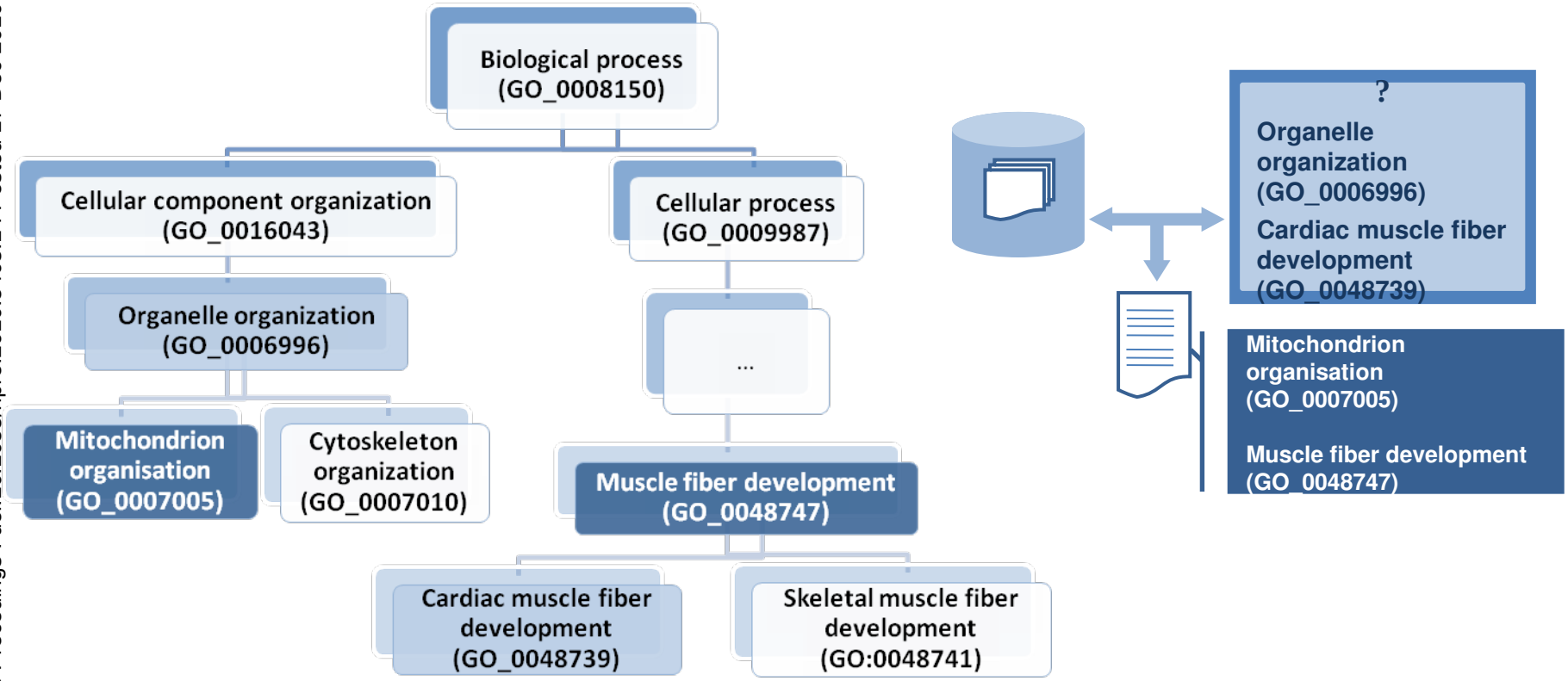
Hyponyms and hypernyms to avoid silences



- ⇨ Mix documents that match more or less the query
- ⇨ The selection may be difficult to understand

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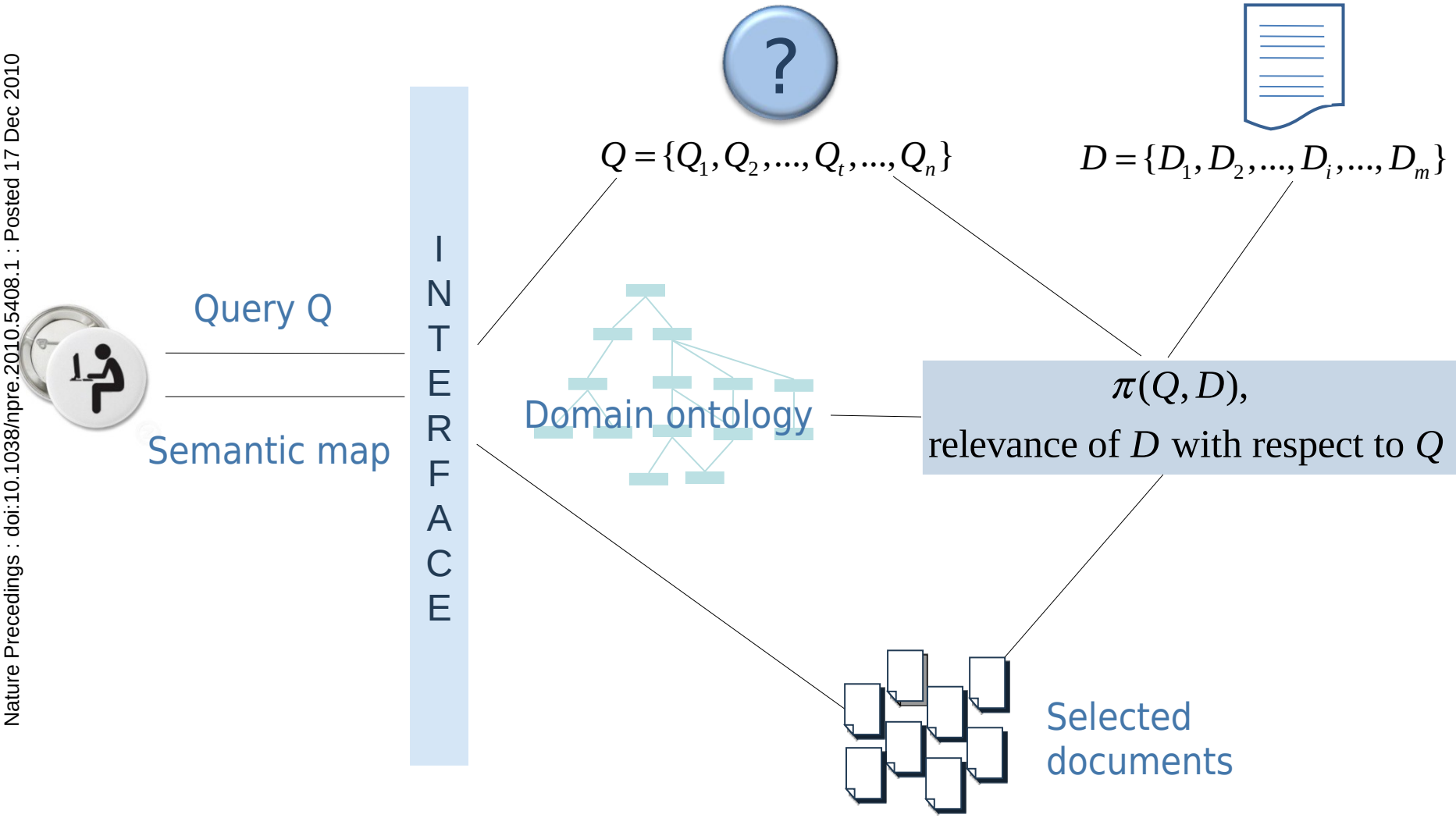

Relevance calculus between a document index and a query

Three-level relevance calculus

- Similarity between two concepts: a concept from the document index and a concept from the query $\pi(Q_t, D_i)$
- Relevance of a document (i.e. the set of its indexing concepts) with respect to a concept from the query $\pi(Q_t, D)$
- Relevance of a document with respect to a query: Fuzzy aggregation of relevance measures $\pi(Q, D)$

⇨ Advantages

- Ranking of documents with respect to their relevance
- Detailed explanation of the document selection

Three-level relevance calculus

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- Relevance of a document with respect to a query: Fuzzy aggregation of relevance measures $\pi(Q, D)$

  - Several similarity measurements have been proposed in literature, this one is easy to understand (% of mutual hyponyms)

$$\pi_{JD}(C_1, C_2) = \begin{cases} \dfrac{hypo(C_1) \quad hypo(C_2)}{hypo(C_1) \quad hypo(C_2)}, & \text{if } C_1 \text{ } \square hypo(C_2) \text{ ou } C_2 \text{ } \square hypo(C_1) \\ 0, & \text{else} \end{cases}$$

Three-level relevance calculus

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  - Best relevance between indexing concepts of document D and a query concept Q_t

$$\pi(Q_t, D) = \max_{0 \; i \; |D|} \pi(Q_t, D_i)$$

  - May be generalized by weighting the concepts D_i (using *evidence codes* in the Gene Ontology for example)

Three-level relevance calculus

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- Relevance of a document with respect to a query: Fuzzy aggregation of relevance measures $\pi(Q, D)$
  - Combine individual relevance scores to estimate an overall relevance of the document
    - Take user preferences into account: decision theory
    - Yager operator (with $q \in \mathbf{R}$)

$$Y_m(\pi(Q_1, D), .., \pi(Q_{|Q|}, D)) = \left(\frac{1}{|Q|} \sum_{t=1}^{|Q|} \pi(Q_t, D)^q\right)^{1/q}$$

q = 1, arithmetic mean,
q → 0, geometrical mean,
q = -1, harmonic mean,
q → +∞, max (OR generalization)
q → -∞, min (AND generalization)

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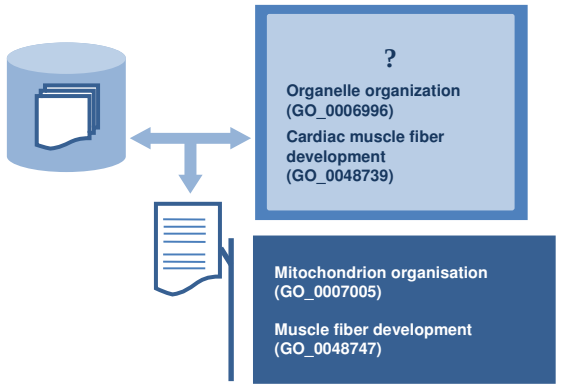
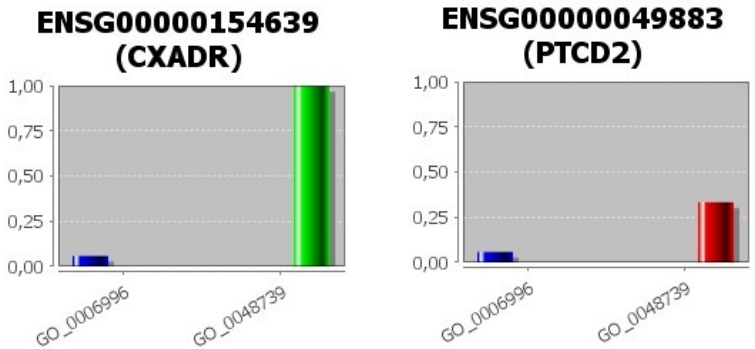
- A document may be selected even if its index contains no terms of the query



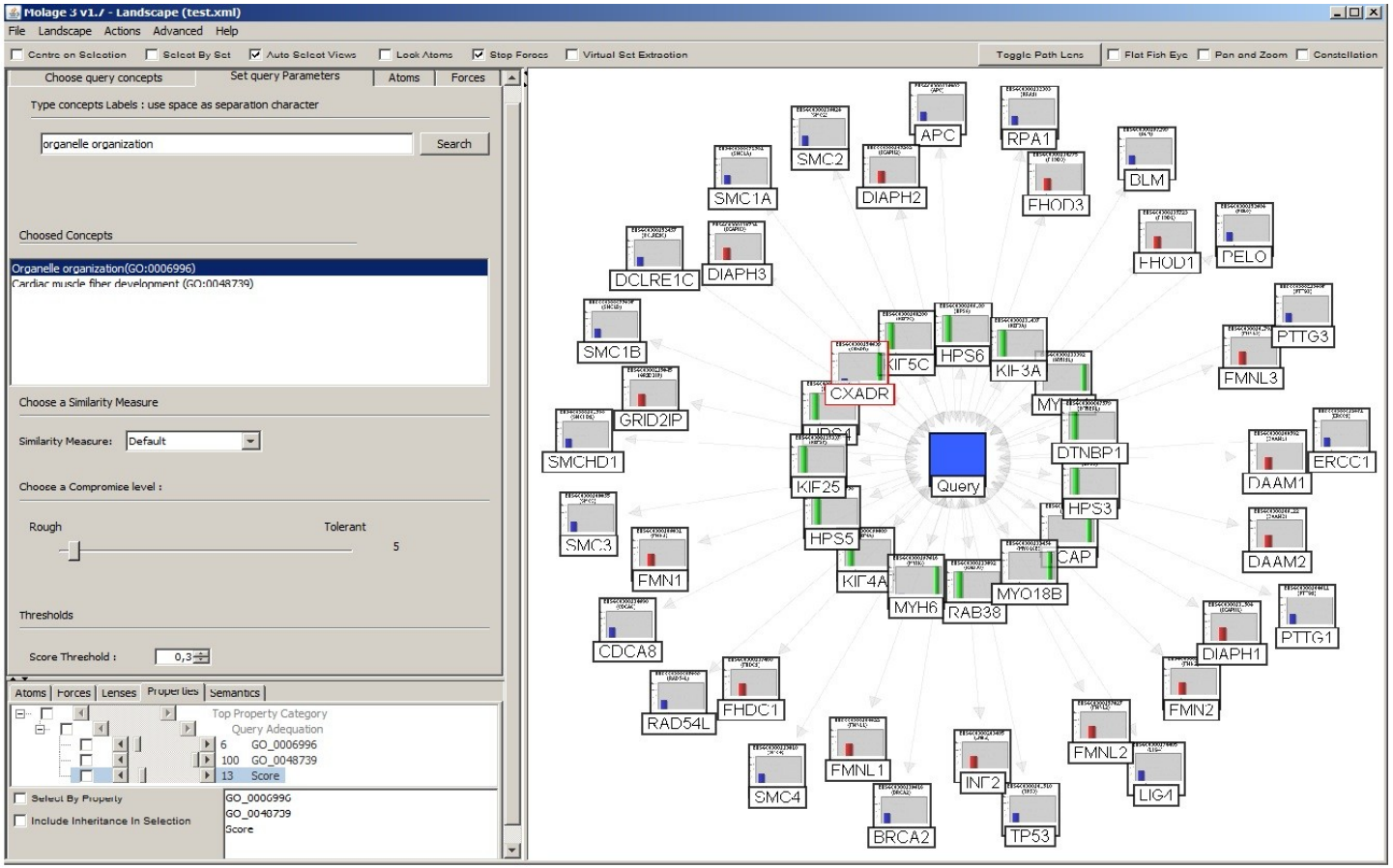
Explain the selection to the user: pictograms

- Each concept of the query is associated with a bar:
  - Its height is proportional to its relevance $\pi(Q_t, D)$
  - Its color says if Q_t
    - index the document (D)
    - specialize (is an hyponym of) D_i
    - generalize (is an hypernym of) D_i



Pictograms are displayed on a semantic map

- Their physical distance to the query is proportional to their relevance score: $\pi(Q, D)$
- Visualization and navigation: fit the human cognitive limits (lens, number of results, relevance threshold…) and help the user (selection of concept for the query…)



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Results

- Find more documents (avoid silences)
- Improve the relevance: documents ranking
- Explain relevance calculus (diagnose)
- Visualize overall results
- Interaction with the list of retrieved documents: customize user preferences
  - ⇨ Iterative improvement of the query

Perspectives

- Improve CHI
- Suggest query reformulation
  - From documents selection by the user (weighting + complement)
  - Underline query terms that are discriminated
- Test several semantic distance calculus on different benchmarks (TREC, Much more…)
- Improve visualization
  - Filter the displayed results using sub-ontologies extraction
  - Propose a view of the results underlining clusters
- Propose an online version

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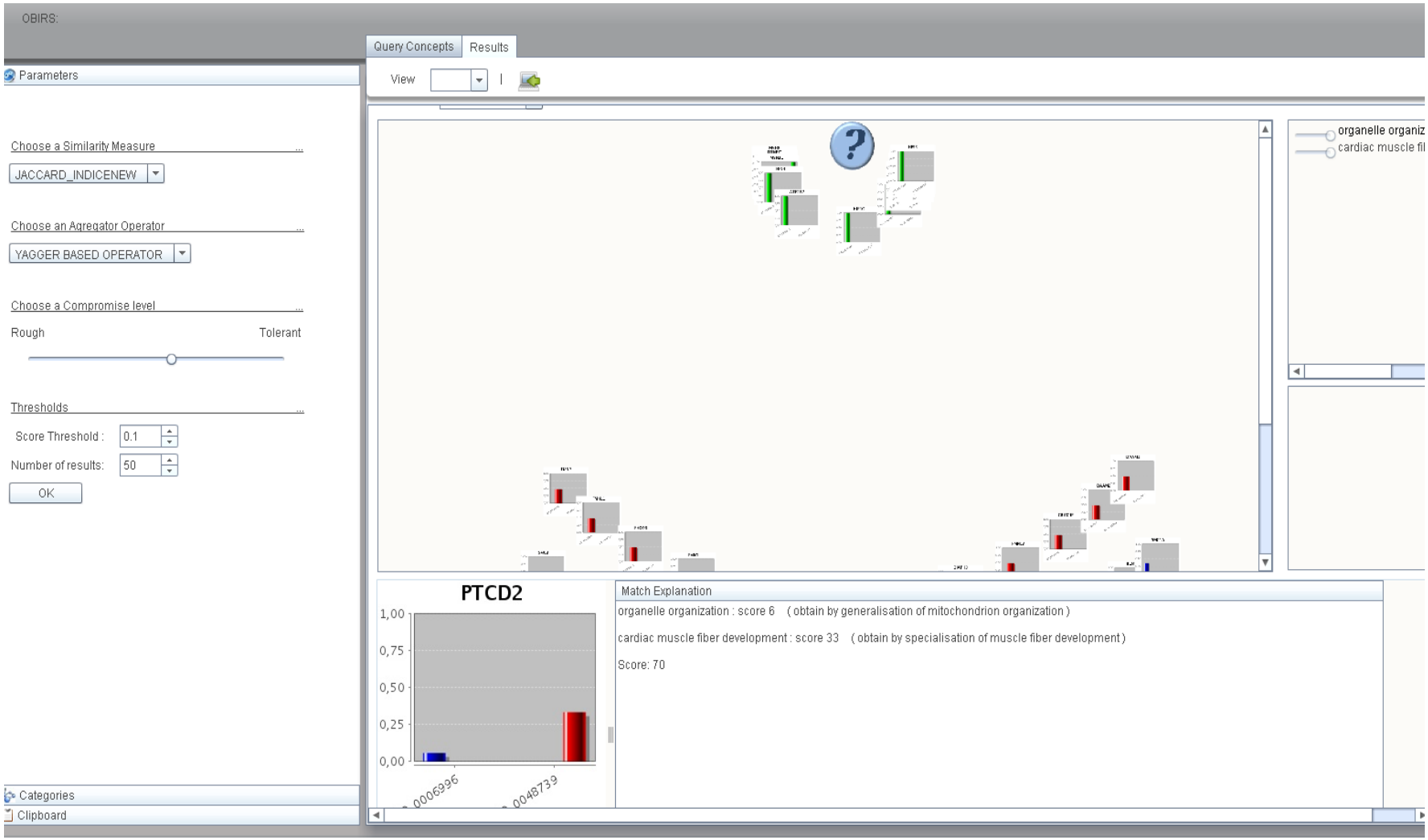
SCIENCES ET TECHNIQUES

OBIRS on line: http://www.ontotoolkit.mines-ales.fr/ObirsClient/



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