Semantic Query Extension through Probabilistic Description Logics

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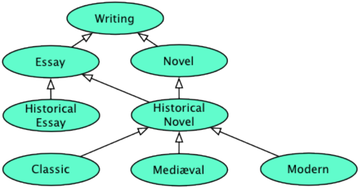
Unirio

URSW 2010

Outline

Semantic Information Retrieval



- Focus: use of ontologies to improve keyword-based search

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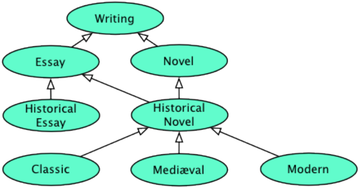

- Focus: use of ontologies to improve keyword-based search
- An ontology can be employed for semantic query extension

Methods

Semantic Query Extension

Identification of semantic concepts contained in user queries

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Probabilistic Ontology

It may not be possible to guarantee that a concept is related to a query $\rightarrow$ uncertainty $\rightarrow$ (PDL) CR$\mathcal{ALC}$

Idea

To obtain all concept instances that are related to a given word even if that word does not appear with the concept

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P(Concept|Query)

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- CR$\mathcal{ALC}$ is a probabilistic extension of the DL $\mathcal{ALC}$.

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- The following constructors are available in $\mathcal{ALC}$: *conjunction* (C $\sqcap$ D), *disjunction* C $\sqcup$ D, *negation* ($\neg$C), *existential* restriction ($\exists r$.C), and value restriction ($\forall r$.C).

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Probabilistic Inclusions and their Semantics

- $P(\mathrm{A}|\mathrm{B}) = \alpha$
- $\forall x \in \mathcal{D} \;:\; P(\mathrm{A(x)}|\mathrm{B(x)}) = \alpha$
- $P(\mathrm{Professor(Maria)}|\mathrm{Researcher(Maria)}) = 0.4$

Example

$P(\text{Animal}) = 0.9$,
$P(\text{Rational}) = 0.6$,
$P(\text{hasChild}) = 0.3$,
$\text{Human} \equiv \text{Animal} \sqcap \text{Rational}$,
$\text{Beast} \equiv \text{Animal} \sqcap \neg\text{Rational}$,
$\text{Parent} \equiv$
$\text{Human} \sqcap \exists\text{hasChild.Human}$,
$P(\text{Kangaroo}|\text{Beast}) = 0.4$,
$P(\text{Kangaroo}|\neg\text{Beast}) = 0.0$,
$\text{MaternityKangaroo} \equiv$
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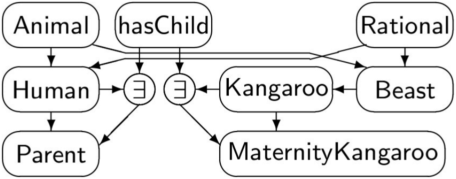

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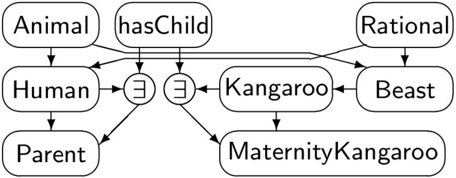

Inference

$$P(\text{Parent}(0)|\text{Human}(0)) = 0.232$$

Proposal

PDL CR$\mathcal{ALC}$ can be useful for semantic query extension

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- Documents are linked to this ontology through indexes
- Search procedure
- Query extension
- Ranking results according to their relevance

Search Procedure

Given a CR$\mathcal{ALC}$ ontology:

- Find a set of documents related to the keywords

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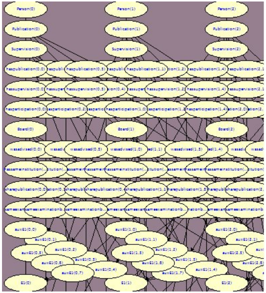

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- Probability of all concepts that are not evidence in the RBN is inferred
- Concepts with highest probabilities are input for the ranking results phase

Ranking Procedure

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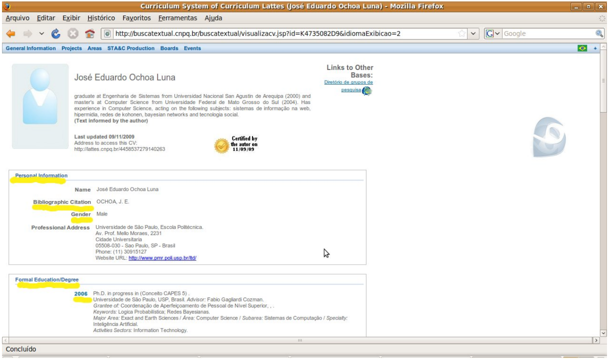
- Merged ordered list is exhibited

The Lattes Curriculum Platform



The Ontology

$$
\begin{array}{ll}
\text{Researcher} \equiv & \text{Person} \\
& \sqcap(\exists \text{hasPublication.Publication} \\
& \sqcap \exists \text{hasSupervision.Supervision} \sqcap \exists \text{hasParticipation.Board}) \\
P(\text{NearCollaborator} & \mid \text{Researcher} \sqcap \exists \text{sharePublication.} \exists \text{hasSameInstitution.} \\
& \text{.Researcher}) = 0.95 \\
\text{FacultyNearCollaborator} \equiv & \text{NearCollaborator} \\
& \sqcap \exists \text{sameExaminationBoard.Researcher} \\
P(\text{NullMobilityResearcher} & \mid \text{Researcher} \sqcap \exists \text{wasAdvised.} \\
& \exists \text{hasSameInstitution.Researcher}) = 0.98 \\
\text{StrongRelatedResearcher} \equiv & \text{Researcher} \\
& \sqcap (\exists \text{sharePublication.Researcher} \sqcap \\
& \exists \text{wasAdvised.Researcher}) \\
\text{InheritedResearcher} \equiv & \text{Researcher} \\
& \sqcap (\exists \text{sameExaminationBoard.Researcher} \sqcap \\
& \exists \text{wasAdvised.Researcher})
\end{array}
$$

Query Results

Goal

Mapping researchers in Bayesian networks

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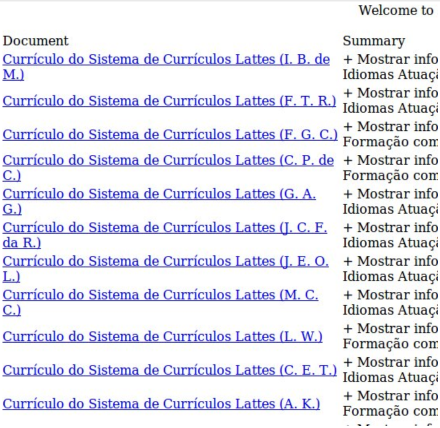
"Bayesian networks"



Welcome to

Document	Summary
Currículo do Sistema de Currículos Lattes (I. B. de M.)	+ Mostrar info Idiomas Atuaçã
Currículo do Sistema de Currículos Lattes (F. T. R.)	+ Mostrar info Idiomas Atuaçã
Currículo do Sistema de Currículos Lattes (F. G. C.)	+ Mostrar info Formação com
Currículo do Sistema de Currículos Lattes (C. P. de C.)	+ Mostrar info Formação com
Currículo do Sistema de Currículos Lattes (G. A. G.)	+ Mostrar info Idiomas Atuaçã
Currículo do Sistema de Currículos Lattes (J. C. F. da R.)	+ Mostrar info Idiomas Atuaçã
Currículo do Sistema de Currículos Lattes (J. E. O. L.)	+ Mostrar info Idiomas Atuaçã
Currículo do Sistema de Currículos Lattes (M. C. C.)	+ Mostrar info Idiomas Atuaçã
Currículo do Sistema de Currículos Lattes (L. W.)	+ Mostrar info Formação com
Currículo do Sistema de Currículos Lattes (C. E. T.)	+ Mostrar info Idiomas Atuaçã
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- Researcher(0) contains "Bayesian networks" in a publication $\rightarrow$ $\text{hasPublication}(0, 1)$ is set to true

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- Researcher(0) contains "Bayesian networks" in a publication $\rightarrow$ $\text{hasPublication}(0, 1)$ is set to true
- Related concepts lead to extensions of the original query $\rightarrow$ $\text{sharePublication}(0, 2)$

Final Result

Semantic Query Extension

Results merged

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Semantic Query Extension

Results merged

Query results for 'bayesian networks'

F. G. C.
- Selected publications
- Supervised works
- Board participations
- Strong related researchers
- Near collaborators

I. B. de M.
- Board participations
- Strong related researchers
- Near collaborators

A. C. F. O.
- Selected publications
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Preliminary Qualitative Analysis

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- 1964 documents were considered
- 20 topics evaluated: “Patern recognition”, “Probabilistic logic”, “Bayesian networks” and so on
- Semantic information retrieval analysis is still an open issue

Conclusions

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- Two basic steps: a) a probabilistic ontology is constructed b) search for instance concepts that best match user queries
- Preliminary results have focused a real-world domain — Lattes scientific repository

Future Work

- Investigate the scalability of our methods

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- Further experiments

The End

Thank you