Top-k Retrieval for Automated Human Resource Management

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Outline

- The need for a semantic Human Resource Management
- Trade-off between scalability and expressivity
- Top-k retrieval for DLR-Lite
- A case study for top-k retrieval: HRM
- System description

Who needs a new HRM system?

- HRM is a “knowledge intensive” task
  - a lot of implicit information
- A pure keyword-based search is inadequate
- Information aggregation

Background tools and techniques

- DLR-Lite: a simple, but interesting Description Logic
  - *Computationally tractable DL to query large databases*
  - *Sub-linear in data complexity*
  - *Good for very large database tables, with limited declarative schema design*
- Top-k query answering over a DLR-Lite knowledge base
  - *We extend the query formalism: conjunctive queries, where fuzzy predicates may appear*

Top-k retrieval for DLR-Lite (1/2)

- **Facts:** a finite set of espressions in the form $R(c_1, \ldots, c_n)$ where R is a n-ary relation and each c_i is a constant.

- Ontology:

$$
\begin{array}{lcl}
Rr & \longrightarrow & A \mid \exists[i_1, \ldots, i_k]R \\
Rl & \longrightarrow & A \mid \exists[i_1, \ldots, i_k]R \mid \\
 & & \exists[i_1, \ldots, i_k]R.(Cond_1 \sqcap \ldots \sqcap Cond_h) \\
Cond & \longrightarrow & ([i] \leq v) \mid ([i] < v) \mid ([i] \geq v) \mid ([i] > v) \mid \\
 & & ([i] = v) \mid ([i] \neq v)
\end{array}
$$

where A is an atomic concept, R is an n-ary relation with $1 \leq i_1, i_2, \ldots, i_k \leq n$, $1 \leq i \leq n$ and v is a reference value for the concrete domain interpretation.

Top-k retrieval for DLR-Lite (2/2)

- $\exists[i_1, \ldots, i_k]R$ is the projection of the relation Ron the columns $i_1, \ldots, i_k$. Hence, $\exists[i_1, \ldots, i_k]R$ has arity k.
- $\exists[i_1, \ldots, i_k]R.(Cond_1 \sqcap \ldots \sqcap Cond_l)$ further restricts the projection $\exists[i_1, \ldots, i_k]R$ according to the conditions specified in $Cond_i$.

  For instance $([i] \leq v)$ specifies that the value of the i-th column have to be less or equal than the valkue v.

Query Language

$$q(\vec{x})[s] \leftarrow \exists \vec{y} R_1(\vec{z}_1), \ldots, R_l(\vec{z}_l), \\ OrderBy(s = f(p_1(\vec{z}'_1), \ldots, p_h(\vec{z}'_h))$$

- q is an n-ary relation (every R_i is an n_i-ary relation) whereas $\vec{x}$ are the related n variables (distinguished variables).
- $\vec{y}$ are the so-called non-distinguished variables.
- $\vec{z}_i, \vec{z}_j{}'$ are tuples of constant or variable values in $\vec{x}$ or $\vec{y}$.
- p_j is an n_j-ary fuzzy predicate assigning to each n_j-ary tuple $\vec{c}_j$ a score $p_j(\vec{c}_j) \in [0, 1]$.
- f is a scoring function $f\colon ([0, 1])^h \rightarrow [0, 1]$, which combines the scores of the h fuzzy predicates $p_j(\vec{c}''_j)$ into an overall score to be assigned to the rule head $q(\vec{c})$.

Top-k Retrieval

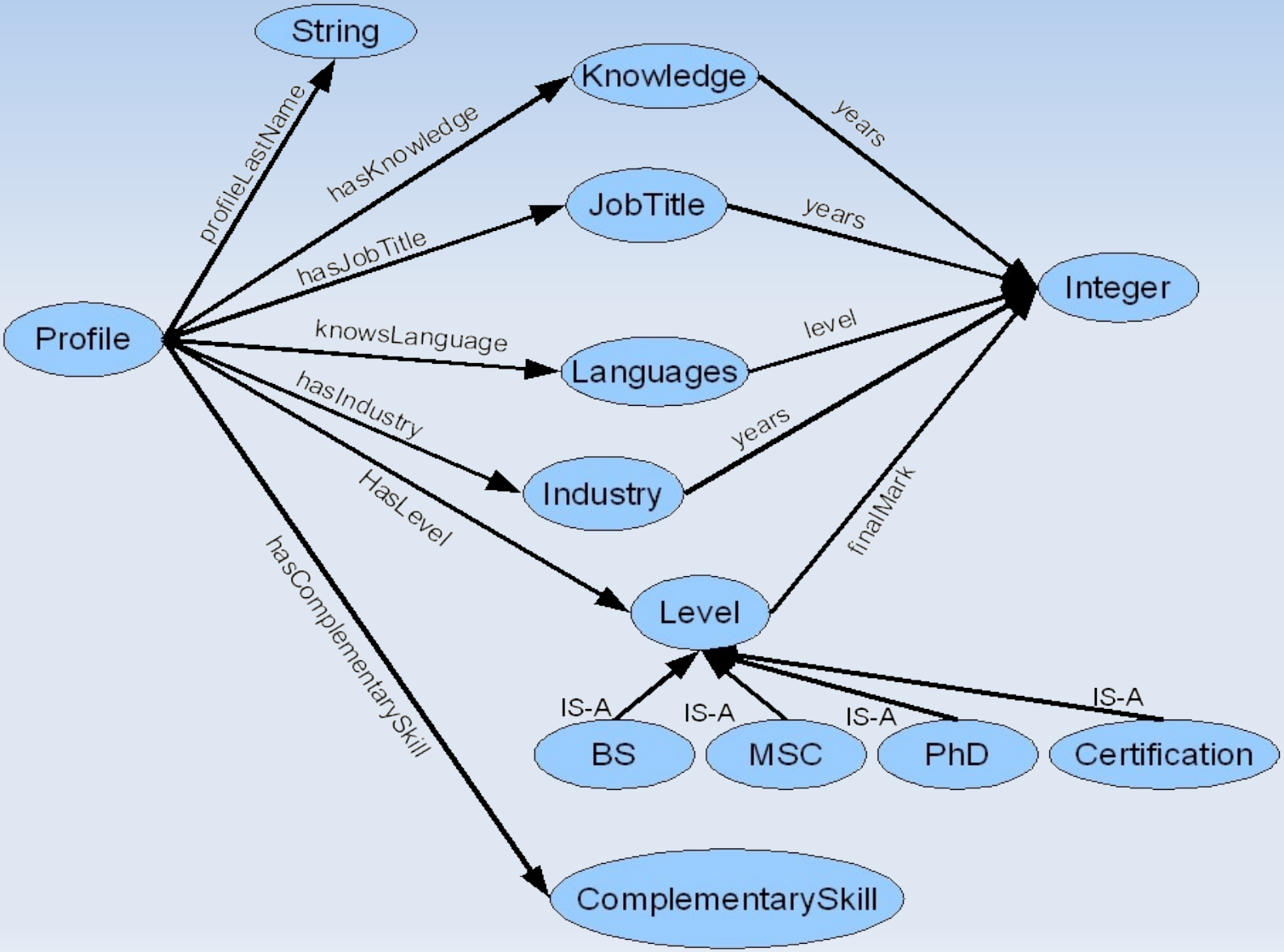
Given a DLR-Lite knowledge base $\mathcal{K}$, and a query

$$q(\vec{x})[s] \leftarrow \exists \vec{y} \phi(\vec{x}, \vec{y})$$

- retrieve k tuples $\langle \vec{c}, s \rangle$ instantiating q with a maximal score
- rank them in decreasing order w.r.t.the score s.

$$ans_k(\mathcal{K}, q) = \mathsf{Top}_k \; ans(\mathcal{K}, q) \; .$$

The HRM domain



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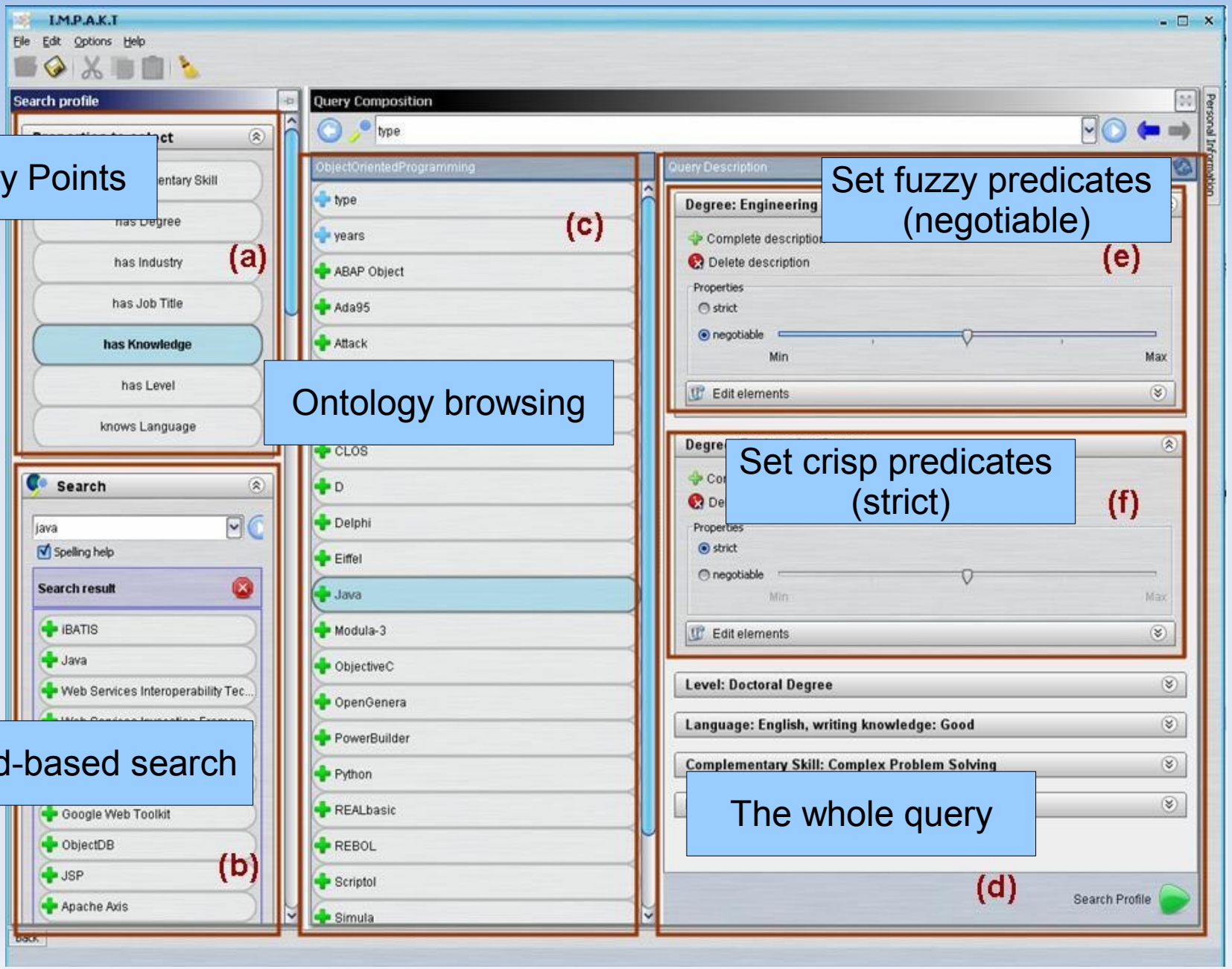
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ABAP Object
Ada95
Attack
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Delphi
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Java
Modula-3
ObjectiveC
OpenGenera
PowerBuilder
Python
REALbasic
REBOL
Scriptol
Simula
(c)
Query Description
Degree: Engineering
Complete description
Delete description
Properties
strict
negotiable
Min
Max
Edit elements
(e)
Properties
strict
negotiable
Edit elements
(f)
Level: Doctoral Degree
Language: English, writing knowledge: Good
Complementary Skill: Complex Problem Solving
(d)
Search Profile
Personal Information
Entry Points
Ontology browsing
Set fuzzy predicates (negotiable)
Set crisp predicates (strict)
Keyword-based search
The whole query

An example of query (1/2)

- Strict:
  - Engineering degree;
- Preferences:
  - Engineering degree final mark >= 103/110;
  - Ph.D.;
  - Java programming and experience >= 6 years;
  - Complex problem solving capabilities;
  - Good written English.

An example of query (2/2)

$$q(id, lastName) \leftarrow$$
$$profileLastName(id, lastName), hasDegree(id, degreeId, mark),$$
$$degreeName(degreeId, degreeName), Engineering\_Degree(degreeId),$$
$$hasLevel(id, levelId, levelmark), levelName(levelId, levelName),$$
$$knowsLanguage(id, lanID, Reading, Verbal, Writing),$$
$$languageName(langID, langName),$$
$$hasKnowledge(id, classID, years, type, level),$$
$$knowledgeName(classID, hasKnowledge),$$
$$hasComplementarySkill(id, classID2), skillName(classID2, capabilities)$$

$$OrderBy(s = rs(mark; 102, 110) \cdot 0.166 +$$
$$pref1(levelName; Doctoral\_Degree) \cdot 0.166 +$$
$$pref1(langName; English) \cdot$$
$$pref4(Writing; NotSpecified/1.0, Basic/3.0, Good/6.0, Excellent/9.0) \cdot 0.166 +$$
$$rs(years; 5, 10) \cdot pref1(hasKnowledge; Java) \cdot 0.166 +$$
$$pref1(capabilities; Complex\_Problem\_Solving) \cdot 0.166)$$

Conclusion and Future Work

- Top-k retrieval for DLR-Lite
- An application for HRM

- Webify the whole system
- Design a (more) user friendly GUI
- Develop a general framework

Q & A