XML Querying Using Ontological Information

Eric Svensson and Artur Wilk

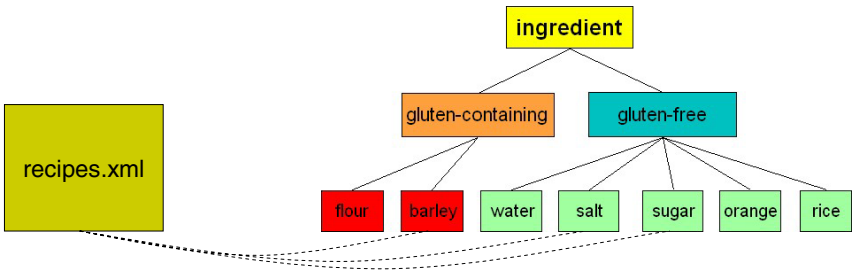
PPSWR'06

Budva, Montenegro

June 11th, 2006

The problem

- Combining querying of XML data with ontology queries
- Example
  - XML document containing recipes
  - Ontology classifying ingredients
  - Query: *Find gluten free recipes*



The approach

- XML query language: Xcerpt
- extended with ontology interface
  - DIG
- Ontology reasoner

Outline

- Preliminaries
  - *Xcerpt*
  - *ontologies and DIG interface*
- *Extended Xcerpt*
  - *Answer filtering*
  - *Ontological information retrieval*
- Conclusions

Xcerpt - Introduction

Xcerpt – query and transformation language for XML [Schaffert *et al.*, 2004]

- inspired by logic programming
- uses pattern matching instead of path navigation

- programs consist of query rules $c \leftarrow Q$
  - the body Q used to extract XML data
  - the head c used to build new XML data
- Core constructs: data terms, query terms, construct terms

Xcerpt constructs

- Data terms
  - model XML documents

```
<CD  price="$10.90">
      <title>Empire Burlesque</title>
      <artist>Bob Dylan</artist>
</CD>
```

```
CD[  attr{ price[ "$10.90" ] },
     title[attr{ }, "Empire  Burlesque"],
     artist[ attr{ }, "Bob Dylan" ]
  ]
```

- Query terms
  - used to match data terms
  - successful matching results in variable bindings (answer substitutions), e.g.

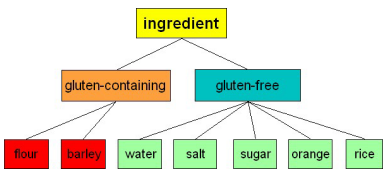
Query term	Data term	Matches?	Answers
a[X]	a["c"]	yes	{ X / "c" }
a[[X]]	a["b", "c"]	yes	{ X / "b" }, { X / "c" }

Xcerpt constructs: *Construct Terms and Query Rules*

- Construct term
  - used to build data terms (by applying answer substitutions)
  - may contain
    - variables e.g. c[X]
    - grouping constructs *all* and *some*
- Query rule **$c \leftarrow Q$**
  - *Q – query terms*
    - connected using *and, or …*
    - possibly associated with external resources
  - *c – construct term,*

Ontologies

- Describe application domains
  - Concepts
  - Individuals: instances of concepts
  - Roles: binary relations between individuals
- Specified by special languages e.g. OWL
- Handled by ontology reasoners e.g. RacerPro



DIG interface

- ontology reasoner interface
- communication through HTTP POST requests
- XML encoded messages
  - **Tell**: managing the knowledge base
  - **Ask**: querying the knowledge base
  - **Response**: replying to the queries

```
<children>
      <catom name="gluten-containing"/>
</children>
```

Ask

```
<conceptSet>
      <synonyms>  <catom name="flour"/>    </synonyms>
      <synonyms>  <catom name="barley"/>  </synonyms>
</conceptSet>
```

Response

9

Extended Xcerpt

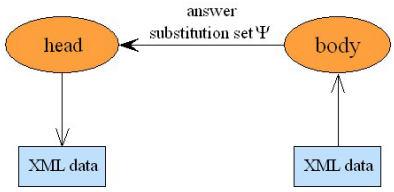
- Xcerpt + ontology reasoner interface
- Communicates with a reasoner using DIG
- Two methods of interaction
  - answer filtering
  - ontological information retrieval

June 11th, 2006

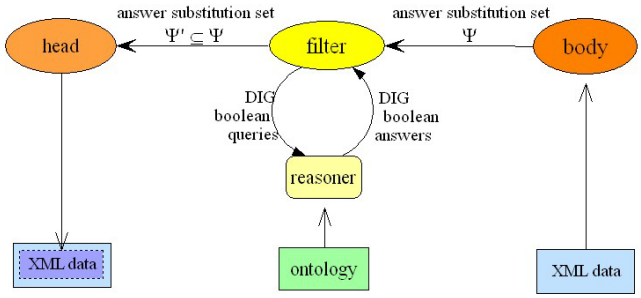
10

Answer filtering

Xcerpt rule



Extended
Xcerpt rule



Answer filtering – example

Query: Find recipes with ingredients containing gluten

```
GOAL
   names [ all var R ] ]
FILTER
   !dig [
      "http://localhost:14159/",
      subsumes [
         catom [ attr { name [ "gluten-containing" ] } ],
         catom [ attr { name [ var N ] } ]
      ]
   ]
FROM
   in [ resource [ "file:recipes.xml" ],
      desc recipe [[
            name [ var R ],
            desc  ingr [[ name [ var N ] ]]
      ]]
   ]
END
```

```
recipes[
   recipe[
      name[ "Recipe1" ],
      ingredients[   ingr[ name[ "sugar" ],
                     ingr[ name[ "orange" ] ] ]
   recipe[
      name[ "Recipe2" ],
      ingredients[  ingr[ name[ "flour" ],
                     ingr[ name[ "salt" ] ] ] ]
```

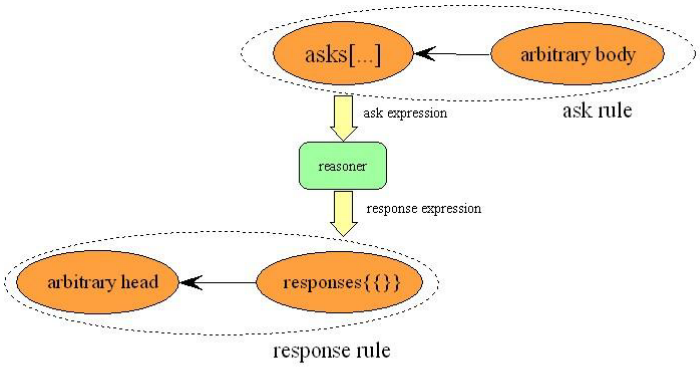
rule result: **names ["Recipe 2"]**

Answer substitutions:

	R	N
before filtering	*"Recipe1"* *"Recipe1"* *"Recipe2"* *"Recipe2"*	*"sugar"* *"orange"* *"flour"* *"salt"*
after filtering	*"Recipe2"*	*"flour"*

Ontological Information retrieval

- DIGging rule: $(h_r \leftarrow b_r) \Leftarrow (h_a \leftarrow b_a)$

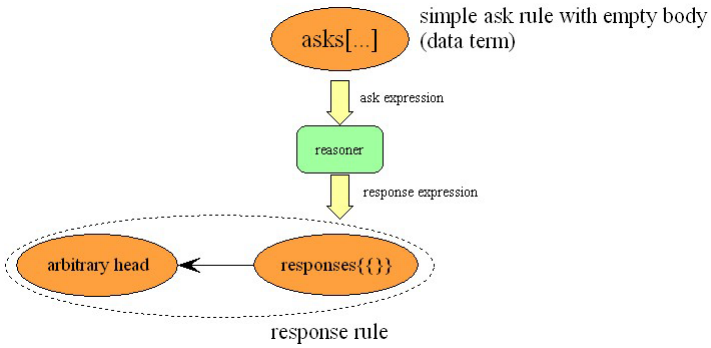


13

Ontological Information retrieval

- simple DIGging rule:

  $(h_r \leftarrow b_r) \Leftarrow h_a$ (fixed ask expression)



14

Ontological information retrieval

- The prototype
  - simple DIGging rules incorporated into Xcerpt goal rules

$(h_r \leftarrow b_r) \Leftarrow h_a$ =

```
GOAL
    h_r
FROM
    in[ !dig[ URL, h_a ], b_r ]
END
```


Ontological information retrieval - example

```
GOAL
   results [ all var C ]
FROM
   in [ !dig [ "http://localhost:14159/",
            asks [
              children [
                attr{ id [ "q1" ] },
                catom [[ attr { name [ "gluten-free" ] } ]]
              ]
            ]
         ],
        responses {{
         conceptSet {{
           attr { id [ "q1" ] },
           synonyms [[
              catom [[ attr { name [ var C ] } ]]
           ]]
         }}
       }}
  ]
END
```

Query result:

```
results [
    "water",
    "rice",
    "salt",
    "orange",
    "sugar"
]
```

DIGging rules limitation

- variable bindings cannot be passed between ask and response rule e.g.

ask[instance[**I**,**C**]] ← q[**I**, **C**]

instance[..] ← response{{ desc “yes” }}

Summary

- Extension of Xcerpt allowing to communicate with an ontology reasoner
  - answer filtering
    - prototype
      - no grouping constructs in filters
      - filters only in goal rules
  - ontology information retrieval
    - cannot be directly used for filtering (no variable passing)
    - prototype
      - simple DIGging rules
      - response rule only as a goal rule

Related work

- Datalog + DL with logical semantics

  AL-log [98], CARIN[98],Rosati[05], Motik et al [05]
  - not applicable to Xcerpt + OWL
- Hybrid framework with fixpoint semantics [Assmann *et al*]
  - ontology reasoning after rule reasoning
- Our approach
  - required modification of Xcerpt system
  - ontology reasoning interleaved with rule reasoning
  - DIGging rules

Future work

- variable passing in DIGging rules
- hybrid implementation
  - DIGging rules handled by external application
- Xquery + ontologies ?