The XML Query Language Xcerpt

Pattern Queries for XML and Semistructured Data

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Introduction

State-of-the-art for XML Query languages (XQuery, XSLT):

- path-oriented
  (e.g. `/descendant::a/descendant::b[following-sibling::c]`)
- patterns serve to assemble path-selections

$\Rightarrow$ strong intertwining of query and construction parts
$\Rightarrow$ queries tend to be complicated

Introduction – Example

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```
<results>
  {
    for $a in distinct-values(document("http://www.bn.com")//author)
    return
        <result>
            { $a }
            {
                for $b in document("http://www.bn.com")/bib/book
                where some $ba in $b/author satisfies deep-equal($ba,$a)
                return $b/title
            }
        </result>
  }
</results>
```

This XQuery expression creates a list of publications (titles) for each author.

Introduction – Xcerpt

- declarative, rule-based transformations and queries
- patterns for *constructing results*
- patterns for *queries* (instead of paths)
- strict separation of query and construction parts – “connected” via variables
- chaining rules instead of nesting queries

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Xcerpt Constructs

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Xcerpt programs build upon the following constructs:

- Database Terms represent semistructured databases / data items
- Query Terms are patterns for querying data
- Construct Terms are patterns for the result of a query

Construct-Query Rules relate Query Terms with Construct Terms.

Database Terms

- Database Terms are representations of XML documents
- Terms are of the form $l\{t_1, \ldots, t_n\}$ or $l[t_1, \ldots, t_n]$ where
  - l is a label (i.e. tag name in XML)
  - $\{t_1, \ldots, t_n\}$ is an unordered (multi-)set of subterms
  - $[t_1, \ldots, t_n]$ is an ordered sequence of subterms
- Terms may contain references (making cycles possible)
  - $a : t$ associates the name a with the subterm t
  - $\uparrow a$ references ("points to") the subterm named a

Database Terms – Example 1

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```
bib {
  a1: author { last{ "Stevens" }, first { "W." } },
  a2: author { last{ "Abiteboul" }, first { "Serge" } },
  a3: author { last{ "Buneman" }, first { "Peter" } },
  a4: author { last{ "Suciu" }, first { "Dan" } },
  book {
    title { "TCP/IP Illustrated" },
    authors [ ↑ a1 ],
    publisher { "Addison-Wesley" },
    price { "65.95" }
  },
  book {
    title { "Advanced Programming in the Unix environment" },
    authors [ ↑ a1 ],
    publisher { "Addison-Wesley" },
    price { "65.95" }
  },
  book {
    title { "Data on the Web" },
    authors [ ↑ a2, ↑ a3, ↑ a4 ],
    publisher { "Morgan Kaufmann Publishers" },
    price { "39.95" }
  }
}
```

Database Terms – Example 2

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```
<reviews>
  <entry>
    <title>Data on the Web</title>
    <price>34.95</price>
    <review>
      A good discussion ...
    </review>
  </entry>
  <entry>
    <title>
      Advanced Programming in the Unix ...
    </title>
    <price>65.95</price>
    <review>
      A clear and detailed ...
    </review>
  </entry>
  <entry>
    <title>TCP/IP Illustrated</title>
    <price>65.95</price>
    <review>
      One of the best books ...
    </review>
  </entry>
</reviews>
```

```
reviews [
  entry [
    title [ "Data on the Web" ],
    price [ "34.95" ],
    review [
      "A good discussion ..."
    ],
  ],
  entry [
    title [
      "Advanced Programming in the Unix ..."
    ],
    price [ "65.95" ],
    review [
      "A clear and detailed ..."
    ],
  ],
  entry [
    title [ "TCP/IP Illustrated" ],
    price [ "65.95" ],
    review [
      "One of the best books ..."
    ]
  ]
]
```

Query Terms

Query Terms . . .

- specify (possibly incomplete) patterns for the data
- are somewhat similar to SQL selections and to goals in logic programming

Query Terms

Query Terms . . .

- specify (possibly incomplete) patterns for the data
- are somewhat similar to SQL selections and to goals in logic programming

. . . but have the following additional properties:

- Answers might have additional subterms to those in the query term.
- Answers might have a different subterm ordering than the query.
- A query term might specify subterms at an unspecified depth.

Query Terms

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Query Terms may contain the following constructs:

- single curly or square brackets ($\{\ \}$, $[\ ]$) denote a total term specification
- double curly or square brackets ($\{\{\ \}\}$, $[[\ ]]$) denote a partial term specification
- variables (possibly with pattern restriction using $\rightsquigarrow$ – read “as”)
- the *desc* construct to specify subterm patterns at unspecified depth

Query Terms – Example 1

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partial vs. total matching:

```
bib {{
  book {{
    title { "Data on the Web" },
  }}
}}
```

matches with the database

```
bib {
  book {
    title { "Data on the Web" },
  }
}
```

does not match with the database

```
bib {
  book {
    title { "TCP/IP Illustrated" },
    authors [ author { last { "Stevens" }, first { "W." } } ],
    publisher { "Addison-Wesley" },
    price { "65.95" }
  },
  book {
    title { "Data on the Web" },
    authors [ author { last { "Abiteboul" }, first { "Serge" } },
              author { last { "Buneman" }, first { "Peter" } },
              author { last { "Suciu" }, first { "Dan" } }        ],
    publisher { "Morgan Kaufmann Publishers" },
    price { "39.95" }
  },
  ...
}
```

Query Terms – Example 2

unrestricted and restricted variables:

```
bib {{
  book {{
    X,
    authors {{ AUTHOR }}
  }}
}}
```

binds e.g. to

```
X=price{ "39.95" } AND
( AUTHOR=author{
          first{"Dan"},
          last{"Suciu"}} OR
  AUTHOR=author{
          first{"Peter"},
          last{"Buneman"}} OR
  AUTHOR=author{
          first{"Serge"},
          last{"Abiteboul"}} )
```

```
bib {{
  book {{
    Y ⇝ title,
    authors {{ AUTHOR }}
  }}
}}
```

binds e.g. to

```
Y=title{"Data on the Web"} AND
( AUTHOR=author{
          first{"Dan"},
          last{"Suciu"}} OR
  AUTHOR=author{
          first{"Peter"},
          last{"Buneman"}} OR
  AUTHOR=author{
          first{"Serge"},
          last{"Abiteboul"}} )
```

Query Terms – Example 3

the *descendant* construct:

```
bib {{
  book {{
    TITLE ⇝ title,
    authors {{ desc "Stevens" }}
  }}
}}
```

matches against a database term with “Stevens” at any depth below the `authors` element.

Semantics – Overview

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A non-standard unification is necessary:

- *partial patterns* (i.e. {{ }} and [[ ]]) have to be treated properly (i.e. the database may contain additional subterms not specified in the query),
- the *descendant* construct which is usually not treated in other unification methods, must be dealt with,
- *ordered* and *unordered* terms ({ } and [ ]) have to be handled according to their semantics.

Semantics – Simulation

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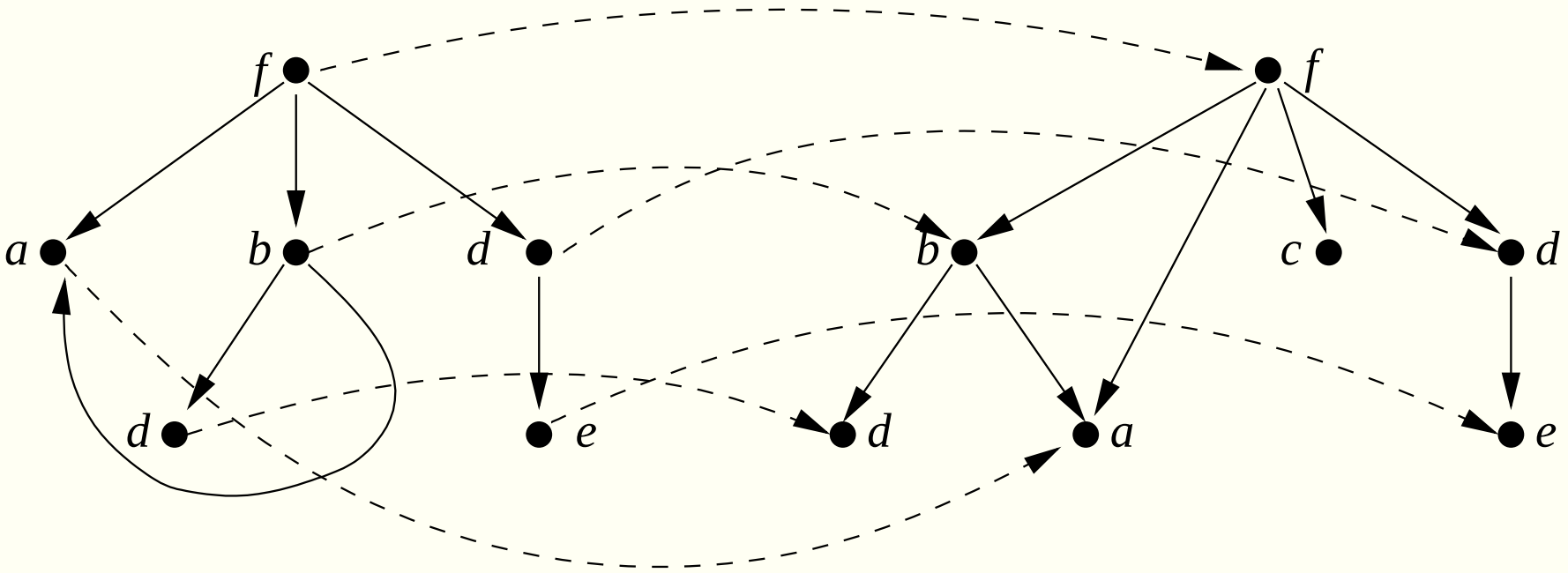
A *Simulation* is a relation between two graphs where one graph can be represented in the other (wrt labels and edges):



Term t_1 simulates into term t_2 – written $t_1 \preceq t_2$

Comparison with XQuery – XQuery

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```
<results>
{
 for $b in
  document("http://bn.com")/bib/book
 return
   <result>
     { $b/title }
     { $b/author  }
   </result>
}
</results>
```

All authors for each title

```
<results>
{
 for $a in
  distinct-values(document("http://bn.com")//author)
 return
  <result>
   { $a }
   {
    for $b in document("http://bn.com")/bib/book
    where some $ba in $b/author
      satisfies deep-equal($ba,$a)
    return $b/title
   }
  </result>
}
</results>
```

All titles for each author

Comparison with XQuery – Xcerpt

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```
rule { cons {
         results {
           all result {
             TITLE,
             all AUTHOR
           }
         }
       },
       query {
         in { "http://bn.com" } ,
         bib {{
           book {{
             TITLE ⇝ title,
             authors {{
               AUTHOR ⇝ author
             }}
           }}
         }}
       }
     }
```

All authors for each title

```
rule { cons {
         results {
           all result {
             all TITLE,
             AUTHOR
           }
         }
       },
       query {
         in { "http://bn.com" } ,
         bib {{
           book {{
             TITLE ⇝ title,
             authors {{
               AUTHOR ⇝ author
             }}
           }}
         }}
       }
     }
```

All titles for each author

Summary

Main features of Xcerpt, a query and transformation language for XML:

- declarative, rule- and term-based querying
- Database Terms represent semistructured databases
- Query Terms are templates that are unified with a database (or another rule)
- Construct Terms are templates for the result, replacing variables with their bindings
- multiple rules may be chained together
- deductive language for both querying/transforming data and deductive reasoning

End

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Thank you!

Xcerpt is an ongoing research project. For more information, please visit http://www.xcerpt.org