Lecture 17: XPath and XQuery

Wednesday, Nov. 7, 2001

XML Query Languages

- Xpath
- Xquery

An Example of XML Data

```
<bib>
    <book>  <publisher> Addison-Wesley </publisher>
            <author> Serge Abiteboul </author>
            <author> <first-name> Rick </first-name>
                     <last-name> Hull </last-name>
            </author>
            <author> Victor Vianu </author>
            <title> Foundations of Databases </title>
             <year> 1995 </year>
    </book>
    <book price="55">
           <publisher> Freeman </publisher>
            <author> Jeffrey D. Ullman </author>
            <title> Principles of Database and Knowledge Base Systems
            </title>
            <year> 1998 </year>
    </book>
</bib>
```

XPath

- Syntax for XML document navigation and node selection
- A *recommendation* of the W3C (i.e. a standard)
- Building block for other W3C standards:
  - XSL Transformations (XSLT)
  - XQuery
  - XML Link (XLink)
  - XML Pointer (XPointer)
- Was originally part of XSL – "XSL pattern language"

XPath: Simple Expressions

/bib/book/year

Result: <year> 1995 </year>
<year> 1998 </year>

/bib/paper/year

Result: empty (there were no papers)

XPath: Restricted Kleene Closure

//author

Result: <author> Serge Abiteboul </author>
<author> <first-name> Rick </first-name>
<last-name> Hull </last-name>
</author>
<author> Victor Vianu </author>
<author> Jeffrey D. Ullman </author>

/bib//first-name
Result: <first-name> Rick </first-name>

Xpath: Text Nodes

/bib/book/author/text()

Result: Serge Abiteboul
Jeffrey D. Ullman

Rick Hull doesn't appear because he has firstname, lastname

Xpath: Wildcard

//author/*

Result: <first-name> Rick </first-name>
<last-name> Hull </last-name>

* Matches any element

Xpath: Attribute Nodes

/bib/book/@price

Result: "55"

@price means that price is has to be an attribute

Xpath: Qualifiers

/bib/book/author[firstname]

Result: <author> <first-name> Rick </first-name>
<last-name> Hull </last-name>
</author>

Xpath: More Qualifiers

/bib/book/author[firstname][address[//zip][city]]/lastname

Result: <lastname> … </lastname>
<lastname> … </lastname>

Xpath: More Qualifiers

/bib/book[@price < "60"]

/bib/book[author/@age < "25"]

/bib/book[author/text()]

Xpath: Summary

bib	matches a bib element
*	matches any element
/	matches the root element
/bib	matches a bib element under root
bib/paper	matches a paper in bib
bib//paper	matches a paper in bib, at any depth
//paper	matches a paper at any depth
paper|book	matches a paper or a book
@price	matches a price attribute
bib/book/@price	matches price attribute in book, in bib

bib/book/[@price<"55"]/author/lastname matches…

Xpath: More Details

- An Xpath expression, p, establishes a relation between:
  - A *context node*, and
  - A node in the *answer set*
- In other words, p denotes a function:
  - S[p] : Nodes -> {Nodes}
- Examples:
  - author/firstname
  - . = self
  - .. = parent
  - part/*/*/subpart/../name = what does it mean ?

The Root and the Root

- <bib> <paper> 1 </paper> <paper> 2 </paper> </bib>
- bib is the "***document element***"
- The "***root***" is above bib
- /bib = returns the document element
- / = returns the root
- Why ? Because we may have comments before and after <bib>; they become siblings of <bib>
- This is advanced xmlogy

Xpath: More Details

- We can navigate along 13 axes:
  - ancestor
  - ancestor-or-self
  - attribute
  - child
  - descendant
  - descendant-or-self
  - following
  - following-sibling
  - namespace
  - parent
  - preceding
  - preceding-sibling
  - self

Xpath: More Details

- Examples:
  - child::author/child:lastname = author/lastname
  - child::author/descendant::zip = author//zip
  - child::author/parent::* = author/..
  - child::author/attribute::age = author/@age

XQuery

- Based on Quilt
  (which is based on XML-QL)
- http://www.w3.org/TR/xquery/
  2/2001
- XML Query data model
  - Ordered !

FLWR ("Flower") Expressions

FOR ... LET... FOR... LET...
WHERE...
RETURN...

XQuery

Find all book titles published after 1995:

```
FOR $x IN document("bib.xml")/bib/book
WHERE $x/year > 1995
RETURN $x/title
```

Result:
<title> abc </title>
<title> def </title>
<title> ghi </title>

XQuery

For each author of a book by Morgan Kaufmann, list all books she published:

```
FOR $a IN distinct(document("bib.xml")
                   /bib/book[publisher="Morgan Kaufmann"]/author)
RETURN <result>
          $a,
          FOR $t IN /bib/book[author=$a]/title
          RETURN $t
       </result>
```

distinct = a function that eliminates duplicates

XQuery

Result:

```
<result>
    <author>Jones</author>
    <title> abc </title>
    <title> def </title>
</result>
<result>
     <author> Smith </author>
     <title> ghi </title>
</result>
```

XQuery

- FOR $x in expr -- binds $x to each value in the list expr
- LET $x = expr -- binds $x to the entire list expr
  - Useful for common subexpressions and for aggregations

XQuery

```
<big_publishers>
    FOR $p IN distinct(document("bib.xml")//publisher)
    LET $b := document("bib.xml")/book[publisher = $p]
    WHERE count($b) > 100
    RETURN $p
</big_publishers>
```

count = a (aggregate) function that returns the number of elms

XQuery

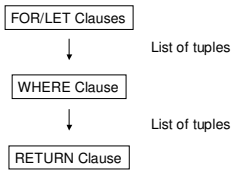
Find books whose price is larger than average:

```
LET $a=avg(document("bib.xml")/bib/book/price)
FOR $b in document("bib.xml")/bib/book
WHERE $b/price > $a
RETURN $b
```

XQuery

Summary:

- FOR-LET-WHERE-RETURN = FLWR



FOR v.s. LET

FOR

- Binds *node variables* → iteration

LET

- Binds *collection variables* → one value

FOR v.s. LET

```
FOR $x IN document("bib.xml")/bib/book
RETURN <result> $x </result>
```

Returns:

```
<result> <book>...</book></result>
<result> <book>...</book></result>
<result> <book>...</book></result>
...
```

```
LET $x IN document("bib.xml")/bib/book
RETURN <result> $x </result>
```

Returns:

```
<result> <book>...</book>
         <book>...</book>
         <book>...</book>
         ...
</result>
```

Collections in XQuery

- Ordered and unordered collections
  - /bib/book/author = an ordered collection
  - Distinct(/bib/book/author) = an unordered collection
- LET $a = /bib/book → $a is a collection
- $b/author → a collection (several authors...)

```
RETURN <result> $b/author </result>
```

Returns:

```
<result> <author>...</author>
         <author>...</author>
         <author>...</author>
         ...
</result>
```

Collections in XQuery

What about collections in expressions ?

- $b/price → list of n prices
- $b/price * 0.7 → list of n numbers
- $b/price * $b/quantity → list of n x m numbers ??
- $b/price * ($b/quant1 + $b/quant2) ≠ $b/price * $b/quant1 + $b/price * $b/quant2 !!

Sorting in XQuery

```
<publisher_list>
  FOR $p IN distinct(document("bib.xml")//publisher)
  RETURN <publisher> <name> $p/text() </name> ,
            FOR $b IN document("bib.xml")//book[publisher = $p]
            RETURN <book>
                        $b/title ,
                        $b/price
                   </book> SORTBY(price DESCENDING)
         </publisher> SORTBY(name)
</publisher_list>
```

Sorting in XQuery

- Sorting arugments: refer to the name space of the RETURN clause, not the FOR clause

If-Then-Else

```
FOR $h IN //holding
RETURN <holding>
            $h/title,
            IF $h/@type = "Journal"
                  THEN $h/editor
            ELSE $h/author
       </holding> SORTBY (title)
```

Existential Quantifiers

```
FOR $b IN //book
WHERE SOME $p IN $b//para SATISFIES
  contains($p, "sailing")
  AND contains($p, "windsurfing")
RETURN $b/title
```

Universal Quantifiers

```
FOR $b IN //book
WHERE EVERY $p IN $b//para SATISFIES
  contains($p, "sailing")
RETURN $b/title
```

Other Stuff in XQuery

- BEFORE and AFTER
  - for dealing with order in the input
- FILTER
  - deletes some edges in the result tree
- Recursive functions
  - Currently: arbitrary recursion
  - Perhaps more restrictions in the future ?