# Introduction to Database Systems CSE 444

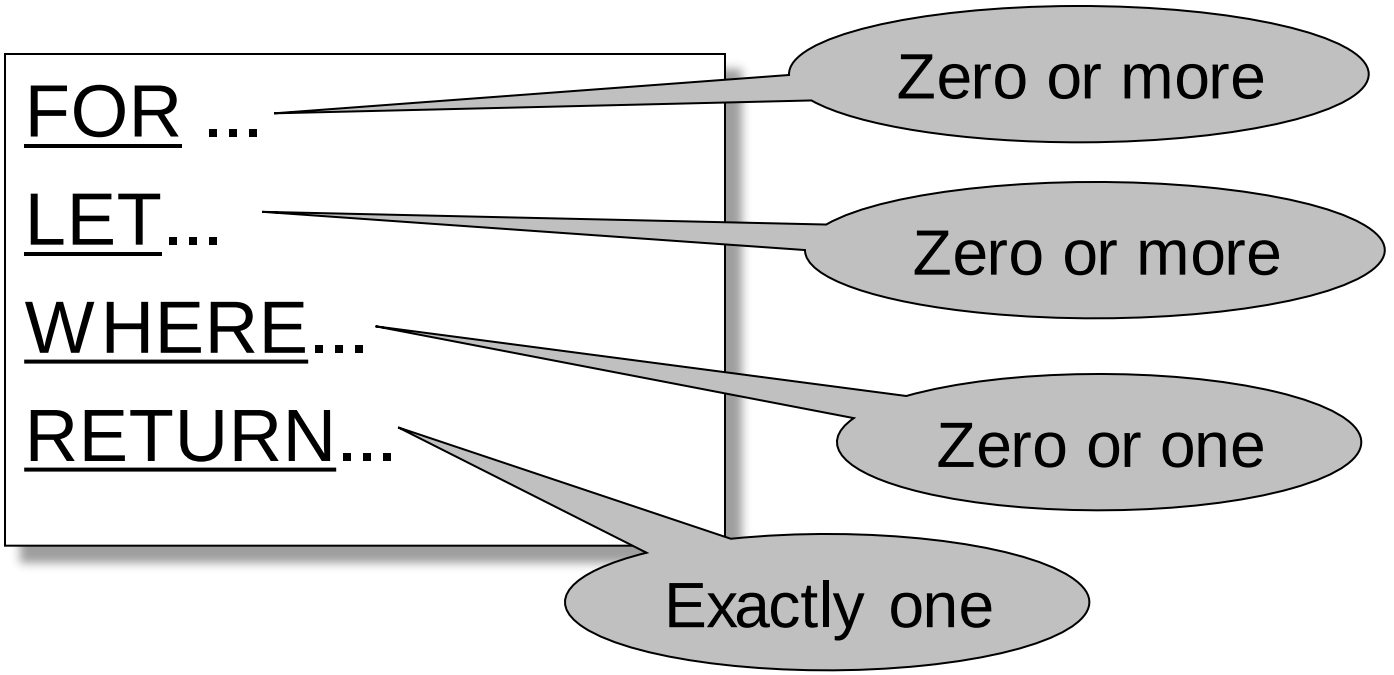
Lecture 26: XQuery

# XQuery

- Standard for high-level querying of databases containing data in XML form
- Based on Quilt, which is based on XML-QL
- Uses XPath to express more complex queries

- Readings
  - Section 12.2
  - [Nothing about XQuery in old Edition]

# FLWR ("Flower") Expressions



# FOR-WHERE-RETURN

Find all book titles published after 1995:

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

Result:

```
<title> abc </title>
<title> def </title>
<title> ghi </title>
```

# FOR-WHERE-RETURN

Equivalently (perhaps more geekish)

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

And even shorter:

```
document("bib.xml")/bib/book[year/text() > 1995] /title
```

# COERCION

The query:

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

Is rewritten by the system into:

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

# FOR-WHERE-RETURN

- Find all book titles and the year when they were published:

```
FOR $x IN document("bib.xml")/ bib/book
RETURN <answer>
                <title>{ $x/title/text() } </title>
                <year>{ $x/year/text() } </year>
            </answer>
```

Result:

```
<answer> <title> abc </title>  <year> 1995 </ year > </answer>
<answer> <title> def </title>  < year > 2002 </ year > </answer>
<answer> <title> ghk </title>  < year > 1980 </ year > </answer>
```

# FOR-WHERE-RETURN

- Notice the use of “{“ and “}”
- What is the result without them ?

```
FOR $x IN document("bib.xml")/ bib/book
RETURN <answer>
                <title> $x/title/text() </title>
                <year> $x/year/text() </year>
              </answer>
```

# FOR-WHERE-RETURN

- Notice the use of “{“ and “}”
- What is the result without them ?

```
FOR $x IN document("bib.xml")/ bib/book
RETURN <answer>
                <title> $x/title/text() </title>
                <year> $x/year/text() </year>
            </answer>
```

<answer> <title> $x/title/text() </title> <year> $x/year/text() </year> </answer>

<answer> <title> $x/title/text() </title> <year> $x/year/text() </year> </answer>

<answer> <title> $x/title/text() </title> <year> $x/year/text() </year> </answer>

# Nesting

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

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

In the RETURN clause comma concatenates XML fragments

# Result

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

# Aggregates

Find all books with more than 3 authors:

```
FOR $x IN document("bib.xml")/bib/book
WHERE count($x/author)>3
RETURN $x
```

count = a function that counts
avg = computes the average
sum = computes the sum
distinct-values = eliminates duplicates

# Aggregates

Same thing:

```
FOR $x IN document("bib.xml")/bib/book[count(author)>3]
RETURN  $x
```

# Eliminating Duplicates

Print all authors:

```
FOR $a IN distinct-values($b/book/author/text())
RETURN <author> { $a } </author>
```

Note: distinct-values applies ONLY to values, NOT elements

# The LET Clause

Find books whose price is larger than average:

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

# Flattening

- Compute a list of (author, title) pairs

**Input**:

```
<book>
    <title> Databases </title>
    <author> Widom </author>
    <author> Ullman </author>
</book>
```

**Output**:

```
<answer>
    <title> Databases </title>
    <author> Widom </author>
</answer>
<answer>
    <title> Databases </title>
    <author> Ullman </author>
</answer>
```

```
FOR $b IN document("bib.xml")/bib/book,
        $x IN $b/title/text(),
        $y IN $b/author/text()
RETURN <answer>
                <title> { $x } </title>
                <author> { $y } </author>
            </answer>
```

# Re-grouping

- For each author, return all titles of her/his books

```
FOR $b IN document("bib.xml")/bib,
        $x IN $b/book/author/text()
RETURN
  <answer>
     <author> { $x } </author>
     { FOR $y IN $b/book[author/text()=$x]/title
        RETURN $y }
  </answer>
```

Result:

```
<answer>
    <author> efg </author>
     <title> abc </title>
     <title> klm </title>
     . . . .
</answer>
```

What about duplicate authors ?

# Re-grouping

- Same, but eliminate duplicate authors:

```
FOR $b IN document("bib.xml")/bib
LET $a := distinct-values($b/book/author/text())
FOR $x IN $a
RETURN
  <answer>
    <author> $x </author>
    { FOR $y IN $b/book[author/text()=$x]/title
      RETURN $y }
  </answer>
```

# Re-grouping

- Same thing:

```
FOR $b IN document("bib.xml")/bib,
        $x IN distinct-values($b/book/author/text())
RETURN
  <answer>
     <author> $x </author>
     { FOR $y IN $b/book[author/text()=$x]/title
        RETURN $y }
  </answer>
```

# SQL and XQuery Side-by-side

Product(pid, name, maker, price)  Find all product names, prices, sort by price

```
SELECT x.name,
       x.price
FROM Product x
ORDER BY x.price
```

SQL

```
FOR $x in document("db.xml")/db/Product/row
ORDER BY $x/price/text()
RETURN <answer>
          { $x/name,  $x/price }
       </answer>
```

XQuery

# XQuery's Answer

```
<answer>
      <name>  abc  </name>
      <price>  7 </price>
</answer>
<answer>
      <name>  def  </name>
      <price>  23 </price>
</answer>
  . . . .
```

Notice: this is NOT a well-formed document ! (WHY ???)

# Producing a Well-Formed Answer

```
<myQuery>
  {  FOR $x in document("db.xml")/db/Product/row
     ORDER BY $x/price/text()
     RETURN <answer>
                    { $x/name,  $x/price }
                </answer>
   }
</myQuery>
```

# XQuery's Answer

```
<myQuery>
  <answer>
        <name>  abc  </name>
        <price>  7 </price>
  </answer>
  <answer>
        <name>  def  </name>
        <price>  23 </price>
  </answer>
    . . . .
</myQuery>
```

Now it is well-formed !

# SQL and XQuery Side-by-side

Product(pid, name, maker, price)
Company(cid, name, city, revenues)

Find all products made in Seattle

```
SELECT x.name
FROM Product x, Company y
WHERE x.maker=y.cid
      and y.city="Seattle"
```

SQL

```
FOR $r in document("db.xml")/db,
        $x in $r/Product/row,
        $y in $r/Company/row
WHERE
    $x/maker/text()=$y/cid/text()
    and  $y/city/text() = "Seattle"
RETURN { $x/name }
```

XQuery

Cool XQuery

```
FOR $y in /db/Company/row[city/text()="Seattle"],
        $x in /db/Product/row[maker/text()=$y/cid/text()]
RETURN { $x/name }
```

```
<product>
        <row> <pid> 123 </pid>
                <name> abc </name>
                <maker> efg </maker>
         </row>
         <row> …. </row>
         …
</product>
<product>
   . . .
</product>
. . . .
```

# SQL and XQuery Side-by-side

For each company with revenues < 1M count the products over $100

```
SELECT y.name, count(*)
FROM Product x, Company y
WHERE x.price > 100 and x.maker=y.cid and y.revenue < 1000000
GROUP BY y.cid, y.name
```

```
FOR $r in document("db.xml")/db,
        $y in $r/Company/row[revenue/text()<1000000]
RETURN
    <proudCompany>
        <companyName>{ $y/name/text() } </companyName>
        <numberOfExpensiveProducts>
            { count($r/Product/row[maker/text()=$y/cid/text()][price/text()>100]) }
        </numberOfExpensiveProducts>
    </proudCompany>
```

# SQL and XQuery Side-by-side

Find companies with at least 30 products, and their average price

```
SELECT y.name, avg(x.price)
FROM Product x, Company y
WHERE x.maker=y.cid
GROUP BY y.cid, y.name
HAVING count(*) > 30
```

An element

A collection

```
FOR $r in document("db.xml")/db,
        $y in $r/Company/row
LET $p := $r/Product/row[maker/text()=$y/cid/text()]
WHERE count($p) > 30
RETURN
    <theCompany>
        <companyName> { $y/name/text()  }
        </companyName>
        <avgPrice> avg($p/price/text()) </avgPrice>
    </theCompany>
```