FAKULTÄT
FÜR !NFORMATIK

Faculty of Informatics

Semi-structured Data

9 - XQuery

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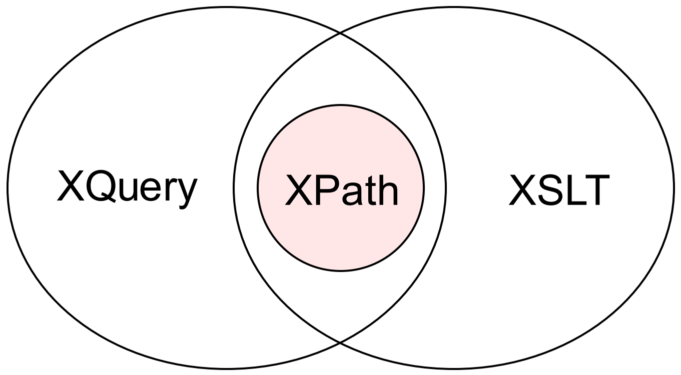
Outline

What is XQuery?

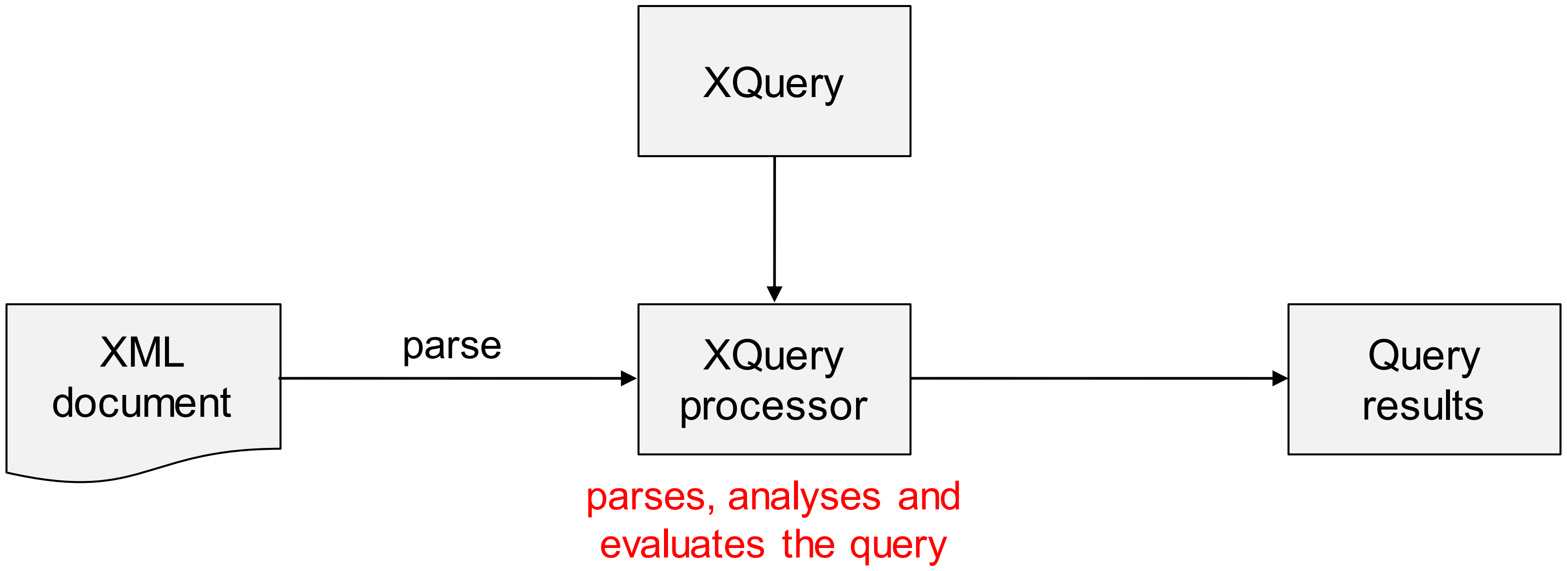
- XQuery is the language for querying XML data
- XQuery for XML is like SQL for relational databases
- XQuery is built on XPath expressions
- As expected, XQuery is a W3C standard

XQuery vs. XPath

- XPath is essentially a subset of XQuery
- XQuery has a number of features not supported by XPath
- XQuery can structure or sort query results (not just select elements and attributes)



Processing XQueries



- Analysis phase: finds syntax errors and other static errors that do not depend on the input document
- Evaluation phase: may raise dynamic errors (e.g., missing input document or division by zero)
- A number of implementations available - http://www.w3.org/XML/Query

XQuery at First Glance

```
<courses>
    <course semester="Summer">
        <title> SSD </title>
        <day> Thursday </day>
        <time> 09:15 </time>
        <location> HS8 </location>
    </course>
    <course semester="Winter">
        <title> Databases </title>
        <day> Tuesday </day>
        <time> 09:15 </time>
        <location> HS8 </location>
    </course>
</courses>
```

```
doc("courses.xml")/courses/course/title
```

```
<title> Semi-structured Data </title>
<title> Databases </title>
```

XQuery at First Glance

```
<courses>
    <course semester="Summer">
        <title> SSD </title>
        <day> Thursday </day>
        <time> 09:15 </time>
        <location> HS8 </location>
    </course>
    <course semester="Winter">
        <title> Databases </title>
        <day> Tuesday </day>
        <time> 09:15 </time>
        <location> HS8 </location>
    </course>
</courses>
```

```
doc("courses.xml")/
        courses/course[@semester="Winter"]
```

```
<course semester="Winter">
    <title> Databases </title>
    <day> Tuesday </day>
    <time> 09:15 </time>
    <location> HS8 </location>
</course>
```

XQuery at First Glance

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<courses>
    <course semester="Summer">
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</courses>
```

```
doc("courses.xml")/
        courses/course[@semester="Winter"]/title
```

```
<title> Databases </title>
```

XQuery at First Glance

```
<courses>
    <course semester="Summer">
        <title> SSD </title>
        <day> Thursday </day>
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    </course>
    <course semester="Winter">
        <title> Databases </title>
        <day> Tuesday </day>
        <time> 09:15 </time>
        <location> HS8 </location>
    </course>
</courses>
```

```
for $x in doc("courses.xml")/courses/course
where $x/@semester="Winter"
return $x/title
```

```
<title> Databases </title>
```

Equivalent to the query

```
doc("courses.xml")/
        courses/course[@semester="Winter"]/title
```

XQuery at First Glance

```
<courses>
    <course semester="Summer">
        <title> SSD </title>
        <day> Thursday </day>
        <time> 09:15 </time>
        <location> HS8 </location>
    </course>
    <course semester="Winter">
        <title> Databases </title>
        <day> Tuesday </day>
        <time> 09:15 </time>
        <location> HS8 </location>
    </course>
</courses>
```

```
for $x in doc("courses.xml")/courses/course
where $x/@semester="Winter"
order by $x/title
return $x/title
```

```
<title> Databases </title>
```

XQuery at First Glance

```
<courses>
    <course semester="Winter">
        <title> SSD </title>
        <day> Thursday </day>
        <time> 09:15 </time>
        <location> HS8 </location>
    </course>
    <course semester="Winter">
        <title> Databases </title>
        <day> Tuesday </day>
        <time> 09:15 </time>
        <location> HS8 </location>
    </course>
</courses>
```

```
for $x in doc("courses.xml")/courses/course
where $x/@semester="Winter"
order by $x/title
return $x/title
```

```
<title> Databases </title>
<title> SSD </title>
```

XQuery at First Glance

```
<courses>
    <course semester="Winter">
        <title> SSD </title>
        <day> Thursday </day>
        <time> 09:15 </time>
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    </course>
    <course semester="Winter">
        <title> Databases </title>
        <day> Tuesday </day>
        <time> 09:15 </time>
        <location> HS8 </location>
    </course>
</courses>
```

```
for $x in doc("courses.xml")/courses/course
where $x/@semester="Winter"
order by $x/title descending
return $x/title
```

```
<title> SSD </title>
<title> Databases </title>
```

Up to Now

- **What is XQuery?**
- **XQuery at First Glance**
- FLWOR Expressions
- Element Constructors
- List, Conditional and Quantified Expressions
- Joins
- Aggregating Values

FLWOR Expressions

- The main engine of XQuery is FLWOR expressions

```
for …
let …
where …
order by …
return …
```

- Pronounced “Flower Expressions”

- Generalize Select-From-Having-Where in SQL

FLWOR Expressions: A Complete Example

```
for $d in doc("departments.xml")//dept_no
let $e := doc("employees.xml")//employee[dept_no = $d]
where count($e) >= 10
order by avg($e/salary) descending
return
    <large_dept>
    {
        $d,
        <size> {count($e)} </size>
        <avg_salary> {avg($e/salary)} </avg_salary>
    }
    </large_dept>
```

a list of departments with at least ten employees, sorted by average salary

FLWOR Expressions: Semantics

```
for $d in doc("departments.xml")//dept_no
let $e := doc("employees.xml")//employee[dept_no  = $d]
where  count($e) >= 10
order  by avg($e/salary)  descending
return
        <large_dept>
        {
                $d,
                <size> {count($e)}  </size>
                <avg_salary>  {avg($e/salary)}  </avg_salary>
        }
        </large_dept>
```

- for generates an ordered list of bindings of dept_no values to $d
- let associates to each binding a further binding of the list of employee elements with that dept_no to $e

$\}$ ordered list of pairs of bindings ($d, $e)

- where filters that list to keep only the desired pairs
- order by sorts that lists by the given criteria
- return constructs for each pair a resulting value

FLWOR Expressions: General Rules

- for and let may be used many times in any order
- Only one where is allowed
- More than one sorting criteria can be specified

  order by <expression> ascending, <expression> descending, …

Difference Between for and let

```
for $x in (1,2,3)
let $y := ("a", "b")
return ($x, $y)
```

```
1, a, b, 2, a, b, 3, a, b
```

```
let $x := (1,2,3)
for $y in ("a", "b")
return ($x, $y)
```

```
1, 2, 3, a, 1, 2, 3, b
```

```
for $x in (1,2,3)
for $y in ("a", "b")
return ($x, $y)
```

```
1, a, 1, b, 2, a, 2, b, 3, a, 3, b
```

```
let $x := (1,2,3)
let $y := ("a", "b")
return ($x, $y)
```

```
1, 2, 3, a, b
```

Up to Now

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Element Constructors

- An XQuery expression may construct a new XML element

- XML constructors can be used to create elements and attributes that appear in the query result
    - Wrapping results in a new element
    - Adding attributes to results

- Another key difference compared to XPath

Element Constructors

Wrapping results in a new element

```
for $d in doc("departments.xml")//dept_no
let $e := doc("employees.xml")//employee[dept_no = $d]
where count($e) >= 10
order by avg($e/salary) descending
return
    <large_dept>
    {
        $d,
        <size> {count($e)} </size>
        <avg_salary> {avg($e/salary)} </avg_salary>
    }
    </large_dept>
```

Element Constructors

Adding attributes to results

```
for $d in doc("departments.xml")//dept_no
let $e := doc("employees.xml")//employee[dept_no = $d]
where count($e) >= 10
order by avg($e/salary) descending
return
    <large_dept name = "{$d}">
        <size> {count($e)} </size>
        <avg_salary> {avg($e/salary)} </avg_salary>
    </large_dept>
```

List Expressions

- XQuery expressions manipulate lists of values
  - Constant lists: (1,2,3)
  - Integer ranges: i to j
  - XPath expressions
- Many operators are supported
  - Concatenation (,)
  - Set operators (union, intersect, except)
- Many functions are supported
  - count, avg, max, min, sum, distinct-values, …

List Expressions: Example

```
for $d in doc("departments.xml")//dept_no
let $e := doc("employees.xml")//employee[dept_no = $d]
where count($e) >= 10
order by avg($e/salary) descending
return
    <large_dept>
    {
        $d,
        <size> {count($e)} </size>
        <avg_salary> {avg($e/salary)} </avg_salary>
    }
    </large_dept>
```

Conditional Expressions

XQuery supports general if-then-else expressions

```
for $b in doc("books.xml")/bookstore/book
return
    if ($b/@category = "children")
    then <child> {$b} </child>
    else <adult> {$b} </adult>
```

ATTENTION: else is required, but it can be just else ()

Quantified Expressions

XQuery allows quantified expressions (exist, forall)

```
for $d in doc("departments.xml")//dept_no
let $e := doc("employees.xml")//employee[dept_no = $d]
where some $s in $e/salary satisfies $s > 1000
return $d
```

```
for $d in doc("departments.xml")//dept_no
let $e := doc("employees.xml")//employee[dept_no = $d]
where every $s in $e/salary satisfies $s > 1000
return $d
```

Joins

Using FLWOR expressions we can join data from multiple sources

```
for $d in doc("departments.xml")//dept_no
let $e := doc("employees.xml")//employee[dept_no = $d]
where count($e) >= 10
order by avg($e/salary) descending
return
    <large_dept>
    {
        $d,
        <size> {count($e)} </size>
        <avg_salary> {avg($e/salary)} </avg_salary>
    }
    </large_dept>
```

Joins

```
for $i in doc("order.xml")//item
let $n := doc("catalog.xml")//product[number = $i/@num]/name
return
    <item  num = "{$i/@num}"
           name = "{$n}"
           quantity = "{$i/@quantity}"/>
```

```
<catalog>
    <product  dept=“D1">
        <number>  130 </number>
        <name> N1  </name>
    </product>
    <product  dept=“D2">
        <number>  230 </number>
        <name> N2  </name>
    </product>
</catalog>
```

```
<order>
    <item dept=“D1"   num="130"   quantity="5"/>
    <item dept="D2"   num="230"   quantity="10"/>
</order>
```

```
<item num="130"  name="N1"  quantity="5"/>

<item num="230"  name="N2"  quantity="10"/>
```

Aggregating Values

```
for $d in distinct-values(doc("order.xml")//item/@dept)
let $i := doc(“order.xml")//item[@dept = $d]
order by $d descending
return <department  name = "{$d}"  totalQuantity = "{sum($i/@quantity)}"/>
```

```
<order>
    <item dept=“D1"   num="130"   quantity="5"/>
    <item dept="D2"   num="230"   quantity=“7"/>
    <item dept=“D1"   num="100"   quantity=“6"/>
    <item dept="D2"   num=“330"   quantity="10"/>
</order>
```

```
<department  name="D2"   totalQuantity="17"/>

<department  name="D1"   totalQuantity="11"/>
```

Sum Up

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