SDXML VT2024
Models and languages for semi-structured data and XML

SQL/XML

SQL/XML

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Corresponding reading
Section 8.3 and chapter 15 of the course book

SQL/XML

Support for XML in relational DB's according to SQL:2003,SQL:2006,SQL:2008,SQL:2011

- **Support for XML in relational databases according to SQL:2003, SQL:2006, SQL:2008, SQL:2011**
  - **SQL/XML: part of the SQL standard**
  - **SQLX: the group behind SQL/XML**
  - **SQLXML: Microsoft's additions to SQL for XML**
- **XML data type**
- **Composition of XML (XML as the result SQL SELECT)**
- **Support for execution of XQuery**
  - **Including XQuery Update Facility (since SQL:2011)**
- **Support for interoperability between XQuery and SQL**

XML data type

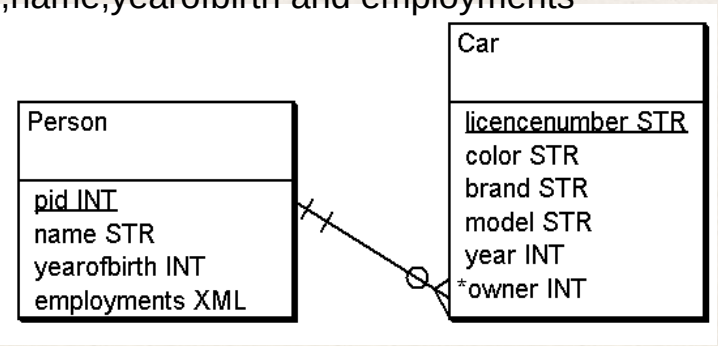
- Store XML, not the serialized version (that would be an ordinary CLOB)
  - According to the XQuery model since SQL:2006
- Every cell is an XML document (or possibly a fragment)
- Support for validation

SQL functions

- XMLELEMENT
- XMLATTRIBUTES
- XMLFOREST
- XMLCONCAT
- XMLCOMMENT
- XMLPI
- XMLNAMESPACES
- XMLAGG
- XMLTEXT
- XMLDOCUMENT
- XMLQUERY
- XMLTABLE
- XMLEXISTS
- XMLSERIALIZE
- XMLPARSE
- XMLCAST
- XMLVALIDATE

Sample data

employments is type XML
pid,name,yearofbirth and employments



Person has pid,name,yearofbirth and employments

PERSON

pid	name	yearofbirth
1	John Higgins	1975
2	Steven Hendry	1973
3	Matthew Stevens	1982
4	Ronnie O´Sullivan	1980
5	Ken Doherty	1974
6	Steve Davis	1960
7	Paul Hunter	1983
8	Neil Robertson	1982

CAR

licencenumber	color	brand	model	year	owner
ABC123	black	NISSAN	Cherry	1995	1
CCD457	blue	FIAT	Forza	2001	2
DKL998	green	SAAB	9000C	1998	3
RSQ199	black	NISSAN	Micra	1999	4
WID387	red	FIAT	Nova	2003	5
ROO197	blue	SAAB	900i	1982	3
TYD226	black	NISSAN	Cherry	1990	1
PTF357	red	VOLVO	V70	2001	6
DAVIS1	red	VOLVO	V90	2007	6

PERSON - pid,name and yearofbirth and employment

employment startdate enddate and employer

car owner = person pid

Sample data

- **The column employments according to this DTD:**

```
<!ELEMENT root (employment*)>
<!ELEMENT employment EMPTY>
<!ATTLIST employment
        startdate CDATA #REQUIRED
        enddate CDATA #IMPLIED
        employer CDATA #REQUIRED>
```

employments according to this DTD
<!ELEMENT root(employment*)>
<!ELEMENT employment EMPTY>
<!ATTLIST employment
startdate CDATA #REQUIRED
enddate CDATA #IMPLIED
employer CDATA #REQUIRED

startdate and employer are required

<!ATTLIST employment startdate enddate employer>

Sample data

- **The column employments according to this XML Schema:**

<complexType name="EmploymentType">

```
<?xml version="1.0"?>
<schema xmlns="http://www.w3.org/2001/XMLSchema">
    <element name="root">
        <complexType>
            <sequence>
                <element name="employment" type="EmploymentType"
                         minOccurs="0" maxOccurs="unbounded" />
            </sequence>
        </complexType>
    </element>
    <complexType name="EmploymentType">
        <attribute name="startdate" type="date" use="required" />
        <attribute name="enddate" type="date" use="optional" />
        <attribute name="employer" type="string" use="required" />
    </complexType>
</schema>
```

<sequence>
<element name="employment"
type="EmploymentType"
minOccurs="0" maxOccurs="unbounded"/>

Sample data

pid	employments
1	<root><employment startdate="2001-08-20" enddate="2009-02-28" employer="ABB"/> <employment startdate="2009-04-15" employer="UPC"/></root>
2	<root><employment startdate="2002-08-20" enddate="2003-06-30" employer="ABB"/> <employment startdate="2003-08-01" employer="UPC"/> <employment startdate="2006-11-01" employer="ABB"/></root>
3	<root><employment startdate="2003-01-10" employer="UPC"/> </root>
4	<root><employment startdate="2002-03-10" enddate="2010-05-22" employer="LKP"/> <employment startdate="2010-08-15" employer="STG"/></root>
5	<root><employment startdate="2002-02-12" enddate="2003-05-11" employer="LKP"/> <employment startdate="2003-05-12" enddate="2003-12-02" employer="ABB"/> <employment startdate="2003-12-06" enddate="2005-02-17" employer="LKP"/> <employment startdate="2005-02-18" enddate="2008-05-16" employer="FFD"/> <employment startdate="2008-06-02" employer="STG"/></root>
6	<root><employment startdate="2001-01-05" enddate="2005-12-31" employer="ABB"/> <employment startdate="2006-01-15" enddate="2009-01-22" employer="LKP"/> <employment startdate="2009-02-01" employer="FFD"/> <employment startdate="2009-02-01" employer="XAB"/></root>
7	<root><employment startdate="2004-01-10" enddate="2008-09-29" employer="FFD"/> <employment startdate="2008-10-01" enddate="2010-11-20" employer="LKP"/></root>
8	<root><employment startdate="2006-02-03" enddate="2008-10-30" employer="UPC"/> <employment startdate="2008-11-20" employer="ABB"/></root>

XMLELEMENT

- Creates an XML element
  - Specify the element's name after the keyword NAME
  - Specify the element's content

```
SELECT XMLELEMENT(NAME "Person", name)
FROM Person
```

```
<Person>John Higgins</Person>
<Person>Stephen Hendry</Person>
<Person>Matthew Stevens</Person>
<Person>Ronnie O'Sullivan</Person>
<Person>Ken Doherty</Person>
<Person>Steve Davis</Person>
<Person>Paul Hunter</Person>
<Person>Neil Robertson</Person>
```

SELECT XMLELEMENT
(NAME "Person",name)
FROM Person

Specify the element's name after keyword NAME.
Then specify element's content.

XMLTEXT

- Creates an XML text node

```
SELECT XMLELEMENT(NAME "Person", XMLTEXT(name))
FROM Person
```

XMLTEXT(name)
creates an XML text node

Same effect as

```
SELECT XMLELEMENT(NAME "Person", name)
FROM Person
```

XMLDOCUMENT

- **Creates an XML document node**

```
SELECT XMLDOCUMENT(XMLELEMENT(NAME "Person", name))
FROM Person
```

Same effect (visibly) as

```
SELECT XMLELEMENT(NAME "Person", name)
FROM Person
```

```
SELECT XMLDOCUMENT (XMLELEMENT(NAME
"Person",name))
FROM Person
```


XMLATTRIBUTES

- **Creates XML attributes**
  - **Used only inside XMLELEMENT**

```
SELECT XMLELEMENT(NAME "Person", XMLATTRIBUTES(yearofbirth), name)
FROM Person
```

```
<Person YEAROFBIRTH="1975">John Higgins</Person>
<Person YEAROFBIRTH="1973">Stephen Hendry</Person>
<Person YEAROFBIRTH="1982">Matthew Stevens</Person>
<Person YEAROFBIRTH="1980">Ronnie O'Sullivan</Person>
<Person YEAROFBIRTH="1974">Ken Doherty</Person>
<Person YEAROFBIRTH="1960">Steve Davis</Person>
<Person YEAROFBIRTH="1983">Paul Hunter</Person>
<Person YEAROFBIRTH="1982">Neil Robertson</Person>
```

```
SELECT XMLELEMENT(NAME "Person",XMLATTRIBUTES(yearofbirth),name)
FROM Person
```

XMLATTRIBUTES

- Can create many attributes
- Attribute names can be specified

XMLATTRIBUTES - yearofbirth

```
SELECT XMLELEMENT(NAME "Person",
                  XMLATTRIBUTES(yearofbirth AS "BirthYear",
                                (SELECT COUNT(*)
                                FROM Car
                                WHERE owner = pid) AS "NumberOfCars"),
                  name)
FROM Person
```

```
<Person BirthYear="1975" NumberOfCars="2">John Higgins</Person>
<Person BirthYear="1973" NumberOfCars="1">Stephen Hendry</Person>
<Person BirthYear="1982" NumberOfCars="2">Matthew Stevens</Person>
<Person BirthYear="1980" NumberOfCars="1">Ronnie O'Sullivan</Person>
<Person BirthYear="1974" NumberOfCars="1">Ken Doherty</Person>
<Person BirthYear="1960" NumberOfCars="2">Steve Davis</Person>
<Person BirthYear="1983" NumberOfCars="0">Paul Hunter</Person>
<Person BirthYear="1982" NumberOfCars="0">Neil Robertson</Person>
```


XMLELEMENT without content

- Does not require content
- Does not require attributes

```
SELECT XMLELEMENT(NAME "Person")
FROM Person
```

```
<Person/>
<Person/>
<Person/>
<Person/>
<Person/>
<Person/>
<Person/>
<Person/>
```

```
SELECT XMLELEMENT(NAME "Person",XMLATTRIBUTES
(yearofbirth,name))
FROM Person
```

```
SELECT XMLELEMENT(NAME "Person", XMLATTRIBUTES(yearofbirth, name))
FROM Person
```

```
<Person YEAROFBIRTH="1975" NAME="John Higgins"/>
<Person YEAROFBIRTH="1973" NAME="Stephen Hendry"/>
<Person YEAROFBIRTH="1982" NAME="Matthew Stevens"/>
<Person YEAROFBIRTH="1980" NAME="Ronnie O'Sullivan"/>
<Person YEAROFBIRTH="1974" NAME="Ken Doherty"/>
<Person YEAROFBIRTH="1960" NAME="Steve Davis"/>
<Person YEAROFBIRTH="1983" NAME="Paul Hunter"/>
<Person YEAROFBIRTH="1982" NAME="Neil Robertson"/>
```

XMLCONCAT

XMLCONCAT - Merges 2 XML values into one

- **Merges two XML values into one**

```
SELECT XMLELEMENT(NAME "Name",name),
XMLELEMENT(NAME "YearOfBirth",yearofbirth)
FROM Person
```

- **Without:**

```
SELECT XMLELEMENT(NAME "Name", name),
XMLELEMENT(NAME "YearOfBirth", yearofbirth)
FROM Person
```

```
<Name>John Higgins</Name>          <YearOfBirth>1975</YearOfBirth>
<Name>Stephen Hendry</Name>        <YearOfBirth>1973</YearOfBirth>
<Name>Matthew Stevens</Name>       <YearOfBirth>1982</YearOfBirth>
<Name>Ronnie O'Sullivan</Name>     <YearOfBirth>1980</YearOfBirth>
<Name>Ken Doherty</Name>           <YearOfBirth>1974</YearOfBirth>
<Name>Steve Davis</Name>           <YearOfBirth>1960</YearOfBirth>
<Name>Paul Hunter</Name>           <YearOfBirth>1983</YearOfBirth>
<Name>Neil Robertson</Name>        <YearOfBirth>1982</YearOfBirth>
```

The result has two columns

Result has 2 columns

XMLCONCAT

- **With:**

```
SELECT XMLCONCAT(XMLELEMENT(NAME "Name", name),
                 XMLELEMENT(NAME "YearOfBirth", yearofbirth))
FROM Person
```

```
<Name>John Higgins</Name><YearOfBirth>1975</YearOfBirth>
<Name>Stephen Hendry</Name><YearOfBirth>1973</YearOfBirth>
<Name>Matthew Stevens</Name><YearOfBirth>1982</YearOfBirth>
<Name>Ronnie O'Sullivan</Name><YearOfBirth>1980</YearOfBirth>
<Name>Ken Doherty</Name><YearOfBirth>1974</YearOfBirth>
<Name>Steve Davis</Name><YearOfBirth>1960</YearOfBirth>
<Name>Paul Hunter</Name><YearOfBirth>1983</YearOfBirth>
<Name>Neil Robertson</Name><YearOfBirth>1982</YearOfBirth>
```

The result has one column!

```
SELECT XMLCONCAT(XMLELEMENT(NAME "Name",name),
XMLELEMENT(NAME "YearOfBirth",yearofbirth)) FROM Person
```

XMLFOREST

XMLFOREST - multiple simple elements at once.

- **Creates multiple simple elements at once**
  - **Returns a fragment (sequence of elements)**

fragment (sequence of elements)

```
SELECT XMLFOREST(name AS "Name",
                 yearofbirth AS "YearOfBirth")
FROM Person
```

```
<Name>John Higgins</Name><YearOfBirth>1975</YearOfBirth>
<Name>Stephen Hendry</Name><YearOfBirth>1973</YearOfBirth>
<Name>Matthew Stevens</Name><YearOfBirth>1982</YearOfBirth>
<Name>Ronnie O'Sullivan</Name><YearOfBirth>1980</YearOfBirth>
<Name>Ken Doherty</Name><YearOfBirth>1974</YearOfBirth>
<Name>Steve Davis</Name><YearOfBirth>1960</YearOfBirth>
<Name>Paul Hunter</Name><YearOfBirth>1983</YearOfBirth>
<Name>Neil Robertson</Name><YearOfBirth>1982</YearOfBirth>
```


Nesting

Nesting of XMLELEMENT statements

```
SELECT XMLELEMENT(NAME "Person",
                  XMLATTRIBUTES(pid AS "ID"),
                  XMLELEMENT(NAME "Info",
                             XMLATTRIBUTES(name AS "About"),
                             XMLFOREST((SELECT COUNT(*)
                                        FROM Car
                                        WHERE owner = pid) AS "Cars",
                                       yearofbirth AS "YoB")))
FROM Person
```

```
<Person ID="1"><Info About="John Higgins"><Cars>2</Cars><YoB>1975</YoB></Info></Person>
<Person ID="2"><Info About="Stephen Hendry"><Cars>1</Cars><YoB>1973</YoB></Info></Person>
<Person ID="3"><Info About="Matthew Stevens"><Cars>2</Cars><YoB>1982</YoB></Info></Person>
<Person ID="4"><Info About="Ronnie O'Sullivan"><Cars>1</Cars><YoB>1980</YoB></Info></Person>
<Person ID="5"><Info About="Ken Doherty"><Cars>1</Cars><YoB>1974</YoB></Info></Person>
<Person ID="6"><Info About="Steve Davis"><Cars>2</Cars><YoB>1960</YoB></Info></Person>
<Person ID="7"><Info About="Paul Hunter"><Cars>0</Cars><YoB>1983</YoB></Info></Person>
<Person ID="8"><Info About="Neil Robertson"><Cars>0</Cars><YoB>1982</YoB></Info></Person>
```

XMLAGG

- Aggregates many XML values into one
- An aggregate function (like COUNT, SUM, etc.)
  - Either all rows become a group
  - Or groups are created based on GROUP BY

```
SELECT XMLAGG(XMLELEMENT(NAME "Person", name))
FROM Person
```

```
<Person>John Higgins</Person><Person>Stephen
Hendry</Person><Person>Matthew Stevens</Person><Person>Ronnie
O'Sullivan</Person><Person>Ken Doherty</Person><Person>Steve
Davis</Person><Person>Paul Hunter</Person><Person>Neil
Robertson</Person>
```

The whole result is one row and one column (one cell)

XMLAGG

- And a root element in order to get well-formed XML

```
SELECT XMLELEMENT(NAME "People",
    XMLAGG(XMLELEMENT(NAME "Person", name)))'
FROM Person
```

```
<People><Person>John Higgins</Person><Person>Stephen
Hendry</Person><Person>Matthew Stevens</Person><Person>Ronnie
O'Sullivan</Person><Person>Ken Doherty</Person><Person>Steve
Davis</Person><Person>Paul Hunter</Person><Person>Neil
Robertson</Person></People>
```

Want to put a root element to make it well formed XML.

XMLAGG - and a root element to get well formed XML.
SELECT XMLELEMENT (NAME "People",

The previous result indented

```
<People>
   <Person>John Higgins</Person>
   <Person>Stephen Hendry</Person>
   <Person>Matthew Stevens</Person>
   <Person>Ronnie O'Sullivan</Person>
   <Person>Ken Doherty</Person>
   <Person>Steve Davis</Person>
   <Person>Paul Hunter</Person>
   <Person>Neil Robertson</Person>
</People>
```


XMLAGG with GROUP BY

- One result per group
  - Aggregated vs grouped columns (as usual)

```
SELECT XMLELEMENT(NAME "Color",
                  XMLATTRIBUTES(color AS "Name"),
                  XMLAGG(XMLELEMENT(NAME "Car", licencenumber)))
FROM Car
GROUP BY color
```

```
<Color Name="black"><Car>ABC123</Car><Car>TYD226</Car><Car>RSQ199</Car></Color>
<Color Name="blue"><Car>CCD457</Car><Car>ROO197</Car></Color>
<Color Name="green"><Car>DKL998</Car></Color>
<Color Name="red"><Car>PTF357</Car><Car>WID387</Car><Car>DAVIS1</Car></Color>
```

XMLAGG with GROUP BY

```
SELECT XMLELEMENT (NAME "Color",
XMLATTRIBUTES(color AS "Name"),
XMLAGG(XMLELEMENT(NAME "Car",licensenumber))
FROM Car
GROUP BY Color
```

XMLAGG with GROUP BY

```
SELECT XMLELEMENT(NAME "Color",
                  XMLATTRIBUTES(color AS "Name"),
                  XMLAGG(XMLELEMENT(NAME "Car",
                                    XMLFOREST(licencenumber AS "Lnr", name AS "Owner"))))
FROM Car, Person
WHERE owner = pid
GROUP BY color
```

```
<Color Name="black"><Car><Lnr>ABC123</Lnr><Owner>John Higgins</Owner></Car><Car><Lnr>TYD226</Lnr><Owner>John Higgins</Owner></Car><Car><Lnr>RSQ199</Lnr><Owner>Ronnie O'Sullivan</Owner></Car></Color>
<Color Name="blue"><Car><Lnr>CCD457</Lnr><Owner>Stephen Hendry</Owner></Car><Car><Lnr>ROO197</Lnr><Owner>Ken Doherty</Owner></Car></Color>
<Color Name="green"><Car><Lnr>DKL998</Lnr><Owner>Matthew Stevens</Owner></Car></Color>
<Color Name="red"><Car><Lnr>PTF357</Lnr><Owner>Steve Davis</Owner></Car><Car><Lnr>WID387</Lnr><Owner>Matthew Stevens</Owner></Car><Car><Lnr>DAVIS1</Lnr><Owner>Steve Davis</Owner></Car></Color>
```


XMLAGG with GROUP BY

```
SELECT XMLELEMENT(NAME "CarColors", XMLAGG(colorxml))
FROM (SELECT XMLELEMENT(NAME "Color",
                        XMLATTRIBUTES(color AS "Name"),
                        XMLAGG(XMLELEMENT(NAME "Car",
                                          XMLFOREST(licencenumber AS "Lnr",
                                                    name AS "Owner")))) AS colorxml
      FROM Car, Person
      WHERE owner = pid
      GROUP BY color) AS innertable
```

```
<CarColors><Color Name="black"><Car><Lnr>ABC123</Lnr><Owner>John Higgins</Owner></Car><Car><Lnr>TYD226</Lnr><Owner>John Higgins</Owner></Car><Car><Lnr>RSQ199</Lnr><Owner>Ronnie O'Sullivan</Owner></Car></Color><Color Name="blue"><Car><Lnr>CCD457</Lnr><Owner>Stephen Hendry</Owner></Car><Car><Lnr>ROO197</Lnr><Owner>Ken Doherty</Owner></Car></Color><Color Name="green"><Car><Lnr>DKL998</Lnr><Owner>Matthew Stevens</Owner></Car></Color><Color Name="red"><Car><Lnr>PTF357</Lnr><Owner>Steve Davis</Owner></Car><Car><Lnr>WID387</Lnr><Owner>Matthew Stevens</Owner></Car><Car><Lnr>DAVIS1</Lnr><Owner>Steve Davis</Owner></Car></Color></CarColors>
```

The previous result indented

```
<?xml version="1.0" encoding="UTF-8"?>
<CarColors>
  <Color Name="black">
    <Car>
      <Lnr>ABC123</Lnr>
      <Owner>John Higgins</Owner>
    </Car>
    <Car>
      <Lnr>TYD226</Lnr>
      <Owner>John Higgins</Owner>
    </Car>
    <Car>
      <Lnr>RSQ199</Lnr>
      <Owner>Ronnie O'Sullivan</Owner>
    </Car>
  </Color>
  <Color Name="blue">
    <Car>
      <Lnr>CCD457</Lnr>
      <Owner>Stephen Hendry</Owner>
    </Car>
    <Car>
      <Lnr>ROO197</Lnr>
      <Owner>Ken Doherty</Owner>
    </Car>
  </Color>
  <Color Name="green">
    <Car>
      <Lnr>DKL998</Lnr>
      <Owner>Matthew Stevens</Owner>
    </Car>
  </Color>
  <Color Name="red">
    <Car>
      <Lnr>PTF357</Lnr>
      <Owner>Steve Davis</Owner>
    </Car>
    <Car>
      <Lnr>WID387</Lnr>
      <Owner>Matthew Stevens</Owner>
    </Car>
    <Car>
      <Lnr>DAVIS1</Lnr>
      <Owner>Steve Davis</Owner>
    </Car>
  </Color>
</CarColors>
```


XMLCOMMENT

- Creates an XML comment

```
SELECT XMLCOMMENT('Nice weather...')
FROM Person
```

```
<!--Nice weather...-->
<!--Nice weather...-->
<!--Nice weather...-->
<!--Nice weather...-->
<!--Nice weather...-->
<!--Nice weather...-->
<!--Nice weather...-->
<!--Nice weather...-->
```

XMLCOMMENT dynamic content

```
SELECT XMLELEMENT(NAME "People",
        XMLAGG(XMLCONCAT(XMLCOMMENT('Here comes an element for the person with pid ' CONCAT pid),
                                XMLFOREST(name AS "Person"))))
FROM Person
```

```
<People><!--Here comes an element for the person with pid 1--><Person>John Higgins</Person><!--Here comes an element for the person with pid 2--><Person>Stephen Hendry</Person><!--Here comes an element for the person with pid 3--><Person>Matthew Stevens</Person><!--Here comes an element for the person with pid 4--><Person>Ronnie O'Sullivan</Person><!--Here comes an element for the person with pid 5--><Person>Ken Doherty</Person><!--Here comes an element for the person with pid 6--><Person>Steve Davis</Person><!--Here comes an element for the person with pid 7--><Person>Paul Hunter</Person><!--Here comes an element for the person with pid 8--><Person>Neil Robertson</Person></People>
```


The previous result indented

```
<People>
  <!--Here comes an element for the person with pid 1-->
  <Person>John Higgins</Person>
  <!--Here comes an element for the person with pid 2-->
  <Person>Stephen Hendry</Person>
  <!--Here comes an element for the person with pid 3-->
  <Person>Matthew Stevens</Person>
  <!--Here comes an element for the person with pid 4-->
  <Person>Ronnie O'Sullivan</Person>
  <!--Here comes an element for the person with pid 5-->
  <Person>Ken Doherty</Person>
  <!--Here comes an element for the person with pid 6-->
  <Person>Steve Davis</Person>
  <!--Here comes an element for the person with pid 7-->
  <Person>Paul Hunter</Person>
  <!--Here comes an element for the person with pid 8-->
  <Person>Neil Robertson</Person>
</People>
```

XMLPI

- Creates an XML processing instruction

```
SELECT XMLPI(NAME "Congrats", 'to="everybody"')
FROM Person
```

```
<?Congrats to="everybody"?>
<?Congrats to="everybody"?>
<?Congrats to="everybody"?>
<?Congrats to="everybody"?>
<?Congrats to="everybody"?>
<?Congrats to="everybody"?>
<?Congrats to="everybody"?>
<?Congrats to="everybody"?>
```


XMLPI

- It does not have to look like it has attributes

```
SELECT XMLPI(NAME "Congrats", 'ladies and gentlemen')
FROM Person
```

```
<?Congrats ladies and gentlemen?>
<?Congrats ladies and gentlemen?>
<?Congrats ladies and gentlemen?>
<?Congrats ladies and gentlemen?>
<?Congrats ladies and gentlemen?>
<?Congrats ladies and gentlemen?>
<?Congrats ladies and gentlemen?>
<?Congrats ladies and gentlemen?>
```

XMLPI

- Dynamic values

```
SELECT XMLPI(NAME "Who is", name)
FROM Person
```

```
<?Who is John Higgins?>
<?Who is Stephen Hendry?>
<?Who is Matthew Stevens?>
<?Who is Ronnie O'Sullivan?>
<?Who is Ken Doherty?>
<?Who is Steve Davis?>
<?Who is Paul Hunter?>
<?Who is Neil Robertson?>
```


XMLNAMESPACES

- Creates namespaces inside and element
  - Must be specified inside XMLELEMENT before XMLATTRIBUTES

```
SELECT XMLELEMENT(NAME "sdxml:Data",
      XMLNAMESPACES('http://ns.dsv.su.se/SDXML' AS "sdxml"),
      XMLFOREST(COUNT(*) AS "sdxml:People",
                (SELECT COUNT(*) FROM Car) AS "sdxml:Cars"))
FROM Person
```

```
<sdxml:Data xmlns:sdxml="http://ns.dsv.su.se/SDXML">
      <sdxml:People>8</sdxml:People>
      <sdxml:Cars>9</sdxml:Cars>
</sdxml:Data>
```

```
SELECT XMLELEMENT(NAME "sdxml:Data",
XMLNAMESPACES('http://ns.dsv.su.se/SDXML' AS "sdxml"),
XMLFOREST(
COUNT(*) AS "sdxml:People",
(SELECT COUNT(*) FROM Car) AS "sdxml:Cars"))
```

XMLNAMESPACES DEFAULT

```
SELECT XMLELEMENT(NAME "Data",
        XMLNAMESPACES(DEFAULT 'http://ns.dsv.su.se/SDXML'),
                XMLFOREST(COUNT(*) AS "People",
                        (SELECT COUNT(*) FROM Car) AS "Cars"))
FROM Person
```

```
<Data xmlns="http://ns.dsv.su.se/SDXML">
        <People>8</People>
        <Cars>9</Cars>
</Data>
```


XMLPARSE

- Converts a serialized XML value to XML
  - DOCUMENT or CONTENT

```
XMLPARSE(DOCUMENT '<root a="1" />')
```

The returned type is XML

```
'<root a="1" />'
```

This is STRING

XMLSERIALIZE

- Serializes an XML value according to the specified data type
  - DOCUMENT or CONTENT (default)
  - Can generate the XML declaration

```
XMLSERIALIZE(xmlvalue AS CLOB)
```

```
XMLSERIALIZE(xmlvalue AS CLOB
             INCLUDING XMLDECLARATION)
```


XMLCAST

- Converts values from and to XML

```
XMLCAST(value AS data type)
```

XMLVALIDATE

- Validates an XML value according to a schema
  - The schema can be specified as a parameter
  - The schema may be part of the XML value
- Returns the validated XML value
  - Or an error

XMLVALIDATE(xmlvalue ACCORDING TO xmlschema)

XMLVALIDATE(xmlvalue)

XMLQUERY

- Executes an XQuery statement
  - Returns XML

```
SELECT XMLQUERY('for $a in (1, 2, 3) return element Number {$a}')
FROM Person
WHERE pid = 1
```

```
<Number>1</Number><Number>2</Number><Number>3</Number>
```

Not actually using anything in Person

XMLQUERY

SELECT name,XMLQUERY

– Can pass column values as parameters

```
SELECT name, XMLQUERY('for $a in distinct-values($e//@employer)
                       return element Employer {$a}'
                       PASSING employments AS "e")
FROM Person
```

John Higgins	<Employer>ABB</Employer><Employer>UPC</Employer>
Stephen Hendry	<Employer>ABB</Employer><Employer>UPC</Employer>
Matthew Stevens	<Employer>UPC</Employer>
Ronnie O'Sullivan	<Employer>LKP</Employer><Employer>STG</Employer>
Ken Doherty	<Employer>LKP</Employer><Employer>ABB</Employer><Employer>FFD</Employer><Employer>STG</Employer>
Steve Davis	<Employer>ABB</Employer><Employer>LKP</Employer><Employer>FFD</Employer><Employer>XAB</Employer>
Paul Hunter	<Employer>FFD</Employer><Employer>LKP</Employer>
Neil Robertson	<Employer>UPC</Employer><Employer>ABB</Employer>

4 employers for these two.

for $a in distinct-values(Employments/employer)
return employer {$a}
name, all employer{$a}

XMLQUERY

```
SELECT name, XMLQUERY('count(distinct-values($e//@employer))'
                       PASSING employments AS "e") AS NumberOfEmployers
FROM Person
```

John Higgins	2
Stephen Hendry	2
Matthew Stevens	1
Ronnie O'Sullivan	2
Ken Doherty	4
Steve Davis	4
Paul Hunter	2
Neil Robertson	2

XMLTABLE

- Creates a table from the result of an XQuery statement

```
SELECT *
FROM XMLTABLE('for $a in (2, 5, 9)
               return element Result {$a}')
```

XMLTABLE - table from result of Xquery statement

```
<Result>2</Result>
<Result>5</Result>
<Result>9</Result>
```


XMLTABLE implicit join

```
SELECT name, t2.*
FROM Person, XMLTABLE('for $a in distinct-values($e//@employer)
                       return element Employer {$a}'
                      PASSING employments AS "e" ) AS t2
```

John Higgins	<Employer>ABB</Employer>
John Higgins	<Employer>UPC</Employer>
Stephen Hendry	<Employer>ABB</Employer>
Stephen Hendry	<Employer>UPC</Employer>
Matthew Stevens	<Employer>UPC</Employer>
Ronnie O'Sullivan	<Employer>LKP</Employer>
Ronnie O'Sullivan	<Employer>STG</Employer>
Ken Doherty	<Employer>LKP</Employer>
Ken Doherty	<Employer>ABB</Employer>
Ken Doherty	<Employer>FFD</Employer>
Ken Doherty	<Employer>STG</Employer>
Steve Davis	<Employer>ABB</Employer>
Steve Davis	<Employer>LKP</Employer>
Steve Davis	<Employer>FFD</Employer>
Steve Davis	<Employer>XAB</Employer>
Paul Hunter	<Employer>FFD</Employer>
Paul Hunter	<Employer>LKP</Employer>
Neil Robertson	<Employer>UPC</Employer>
Neil Robertson	<Employer>ABB</Employer>

```
SELECT name,t2.*
FROM Person,XMLTABLE
('for $a in distinct-values($e//@employer)
return element Employer {$a}'
PASSING employments AS "e") AS t2
```

XMLTABLE columns

```
SELECT name, t2.*
FROM Person, XMLTABLE('$e//employment'
        PASSING employments AS "e"
        COLUMNS employer VARCHAR(10) PATH '@employer',
                startdate DATE PATH '@startdate',
                enddate DATE PATH '@enddate') AS t2
```

```
SELECT name,t2.*
FROM Person,XMLTABLE('$e//employment'
```

NAME	EMPLOYER	STARTDATE	ENDDATE
John Higgins	ABB	2001-08-20	2009-02-28
John Higgins	UPC	2009-04-15	NULL
Stephen Hendry	ABB	2002-08-20	2003-06-30
Stephen Hendry	UPC	2003-08-01	NULL
Stephen Hendry	ABB	2006-11-01	NULL
Matthew Stevens	UPC	2003-01-10	NULL
Ronnie O'Sullivan	LKP	2002-03-10	2010-05-22
Ronnie O'Sullivan	STG	2010-08-15	NULL
Ken Doherty	LKP	2002-02-12	2003-05-11
Ken Doherty	ABB	2003-05-12	2003-12-02
Ken Doherty	LKP	2003-12-06	2005-02-17
Ken Doherty	FFD	2005-02-18	2008-05-16
Ken Doherty	STG	2008-06-02	NULL
Steve Davis	ABB	2001-01-05	2005-12-31
Steve Davis	LKP	2006-01-15	2009-01-22
Steve Davis	FFD	2009-02-01	NULL
Steve Davis	XAB	2009-02-01	NULL
Paul Hunter	FFD	2004-01-10	2008-09-29
Paul Hunter	LKP	2008-10-01	2010-11-20
Neil Robertson	UPC	2006-02-03	2008-10-30
Neil Robertson	ABB	2008-11-20	NULL

XMLTABLE

```
SELECT name AS FullName, COUNT(*) AS NumberOfJobsNow
FROM Person, XMLTABLE('$e//employment[not(@enddate)]'
                PASSING employments AS "e" ) AS t2
GROUP BY name
```

FullName	NumberOfJobsNow
John Higgins	1
Ken Doherty	1
Matthew Stevens	1
Neil Robertson	1
Ronnie O'Sullivan	1
Stephen Hendry	2
Steve Davis	2

```
SELECT t2.*
FROM Person, XMLTABLE('$e//employment[not(@enddate)]'
                PASSING employments AS "e" ) AS t2
WHERE name = 'Stephen Hendry'
```

```
<employment startdate="2003-08-01" employer="UPC"/>
<employment startdate="2006-11-01" employer="ABB"/>
```

XMLTABLE

```
SELECT name, startdate
FROM Person, XMLTABLE('$e//employment[not(@enddate)]/@employer'
                      PASSING employments AS "e"
                      COLUMNS employer VARCHAR(10) PATH '.',
                              startdate VARCHAR(10) PATH '../@startdate') AS t2
WHERE employer = 'UPC'
```

NAME	STARTDATE
John Higgins	2009-04-15
Stephen Hendry	2003-08-01
Matthew Stevens	2003-01-10

XMLTABLE, OUTER JOIN

```
SELECT name, startdate, enddate
FROM Person LEFT OUTER JOIN XMLTABLE('$e//employment[@employer = "ABB"]'
                                     PASSING employments AS "e"
                                     COLUMNS startdate DATE PATH '@startdate',
                                             enddate VARCHAR(10) PATH '@enddate') AS t2
            ON 1=1
```

NAME	STARTDATE	ENDDATE
John Higgins	2001-08-20	2009-02-28
Stephen Hendry	2002-08-20	2003-06-30
Stephen Hendry	2006-11-01	NULL
Matthew Stevens	NULL	NULL
Ronnie O'Sullivan	NULL	NULL
Ken Doherty	2003-05-12	2003-12-02
Steve Davis	2001-01-05	2005-12-31
Paul Hunter	NULL	NULL
Neil Robertson	2008-11-20	NULL

XMLTABLE FOR ORDINALITY

- **FOR ORDINALITY**
  - Special column that enumerates the rows of the result of each call to XMLTABLE

```
SELECT name, ordernr, employer
FROM Person, XMLTABLE('distinct-values($e//employment[@enddate]/@employer)'
                      PASSING employments AS "e"
                      COLUMNS ordernr FOR ORDINALITY,
                              employer VARCHAR(5) PATH 'string()') AS t2
```

John Higgins	1	ABB
Stephen Hendry	1	ABB
Ronnie O'Sullivan	1	LKP
Ken Doherty	1	LKP
Ken Doherty	2	ABB
Ken Doherty	3	FFD
Steve Davis	1	ABB
Steve Davis	2	LKP
Paul Hunter	1	FFD
Paul Hunter	2	LKP
Neil Robertson	1	UPC

XMLEXISTS

- Checks if the result of an XQuery statement is empty

```
SELECT name
FROM Person
WHERE
XMLEXISTS('$e//employment[@employer="ABB"]'
                      PASSING employments AS "e")
```

John Higgins
Stephen Hendry
Ken Doherty
Steve Davis
Neil Robertson

DBMS Support

- Full support according to SQL:2003 and partial support according to SQL:2006, SQL:2008 and SQL:2011
  - IBM DB2 10, 11 (not really full support for XPath)
  - Oracle Database 11g R2, 12c, 18c, 19c, 21c, 23c (some limitations)
  - PostgreSQL 11-14 (limited support, only XPath, no XQuery)
  - OpenLink Virtuoso (limited support)
  - SAP (formerly Sybase) SQL Anywhere 17 (limited support)
- Alternative ways
  - Microsoft

SQL/XML and Java

- Support for the XML data type
  - java.sql.SQLXML
  - can be converted to other Java XML objects with
    - » XMLStreamReader
    - » SAXParser
    - » Transformer (for XSLT)
- Similar facilities in other programming languages

SQL/JSON

- SQL:2016 and SQL:2023
  - Data type JSON
  - JSON-related functions
- Support (more or less)
  - DB2
  - Oracle
  - SQL Server
  - MySQL
  - PostgreSQL
  - MariaDB

What to do next

- Quiz about SQL/XML (Quiz 7)
- Lesson exercises (4)
- Seminar exercises (Assignment 3)
  - Wait until after the lessons