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

Product-specific techniques Microsoft SQL Server

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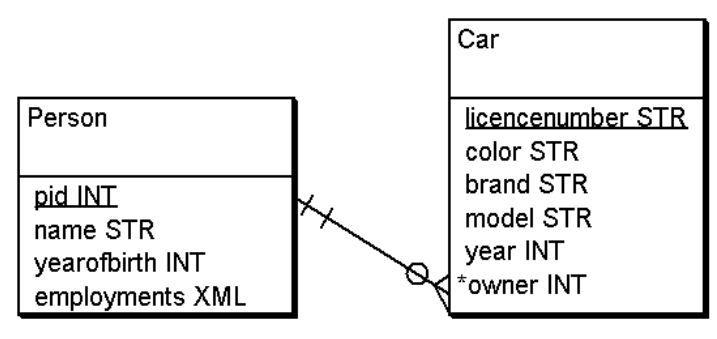
Corresponding reading
Product documentation
Compendium with introduction to Microsoft SQL Server
Section 13.3 of the course book

Microsoft SQL Server 2022

- Data type
  - Support for validation
  - According to the SQL standard
- FOR XML
- OPENXML
- XML methods
  - query (XQuery)
  - value
  - exist
  - modify (DML)
  - nodes
- Limited support for XQuery
  - only few functions
  - not all XPath axes
  - partial support for the let clause

Sample data



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

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>

SQL Server - data type

- XML
  - untyped - well-formed XML and XML fragments
  - typed - associated to an XML Schema
  - No support for DTD
    - » Supports inline DTD for things like default values
- XML SCHEMA COLLECTION
  - register and name XML Schema
  - used to define typed XML
  - CREATE XML SCHEMA COLLECTION name AS 'the full schema'
- Methods
  - query, value, exist, modify, nodes
- Limited support for XPath and XQuery
  - Does not support all XPath axes
  - Does not support all XPath/XQuery functions
  - Does not fully support computed constructors and not in the let clause

SQL Server - typed XML

- The schema must be an XML SCHEMA COLLECTION

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

SQL Server - typed XML

- The schema must be an XML SCHEMA COLLECTION
  - default namespaces

```
CREATE XML SCHEMA COLLECTION employments_xsd AS
'<?xml version="1.0"?>
<schema xmlns="http://www.w3.org/2001/XMLSchema"
                    xmlns:ns="http://ns" targetNamespace="http://ns">
 <element name="root">
  <complexType>
   <sequence>
    <element name="employment" type="ns: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>'
```


SQL Server - typed XML

- A column can be created as typed XML based on an existing XML SCHEMA COLLECTION

```
CREATE TABLE Person (
pid INTEGER NOT NULL IDENTITY (1,1) PRIMARY KEY,
name VARCHAR (30) NOT NULL,
yearofbirth INTEGER NOT NULL,
employments XML(employments_xsd));
```

- The content on the column is validated on INSERT and on UPDATE

SQL Server & SQL/XML

- No support for the publishing functions
  - FOR XML clause in the SELECT statement instead
- No support for XMLQUERY, XMLTABLE, XMLEXISTS
  - XML methods instead (partially aslo OPENXML)
- No support for XMLVALIDATE
  - validation is automatic for typed XML
- No support for XMLCAST
  - The general function CAST is enough (and CONVERT)

SQL Server - OPENXML

- Converts XML data to relational data
- Requires the use of procedures
- Can generate one row per node
  - Default, the result is a so called "edge table"
- Can generate one column per specified expression
  - With the keyword WITH
- Suitable for batch shredding of XML files

SQL Server - FOR XML

- Extra clause in SELECT statements
- Converts the result to XML according to different modes
  - RAW
  - AUTO
  - EXPLICIT (should be avoided)
  - PATH
- The result is always an XML value
  - Either a fragment or well-formed XML with the keyword ROOT
  - Either serialized or of the XML data type with the keyword TYPE

SQL Server - FOR XML RAW

- Every row becomes one element
  - default element name: "row"
  - every column become one attribute

```
SELECT pid, name, yearofbirth
FROM Person
WHERE pid < 4
FOR XML RAW
```

```
<row pid="1" name="John Higgins" yearofbirth="1975" />
<row pid="2" name="Stephen Hendry" yearofbirth="1973" />
<row pid="3" name="Matthew Stevens" yearofbirth="1982" />
```

SQL Server - FOR XML RAW

- ROOT specifies that a root element should be created
  - default element name: "root"
- The element name can be specified
  - root element name after ROOT
  - row element name after RAW

```
SELECT pid, name, yearofbirth
FROM Person
WHERE pid < 4
FOR XML RAW ('Person'), ROOT ('People')
```

```
<People>
  <Person pid="1" name="John Higgins" yearofbirth="1975" />
  <Person pid="2" name="Stephen Hendry" yearofbirth="1973" />
  <Person pid="3" name="Matthew Stevens" yearofbirth="1982" />
</People>
```


SQL Server - FOR XML RAW

- ELEMENTS specifies that elements should be created instead of attributes (for each column)
  - The element names (or attribute names) are based on the SELECT clause

```
SELECT pid AS PersonID, name AS FullName,
                yearofbirth AS YoB
FROM Person
WHERE pid = 2
FOR XML RAW ('Person'), ROOT ('People'), ELEMENTS
```

```
<People>
  <Person>
    <PersonID>2</PersonID>
    <FullName>Stephen Hendry</FullName>
    <YoB>1973</YoB>
  </Person>
</People>
```

SQL Server - FOR XML AUTO

- Elements are created automatically
  - In simple situations, almost identical to RAW
  - default element names: table names or table aliases

```
SELECT pid, name, yearofbirth
FROM Person
WHERE pid < 4
FOR XML AUTO
```

```
<Person pid="1" name="John Higgins" yearofbirth="1975" />
<Person pid="2" name="Stephen Hendry" yearofbirth="1973" />
<Person pid="3" name="Matthew Stevens" yearofbirth="1982" />
```


SQL Server - FOR XML AUTO

- Automatic nesting
  - One element per used table (in FROM and SELECT)
  - Nesting is based on the order of the columns in the SELECT clause
  - Subelement grouping is based on the ORDER BY clause

```
SELECT pid, Name, model, brand, yearofbirth YoB,
            licencenumber, color AS Colour
FROM Person, Car AS Vehicle
WHERE pid < 3 AND owner = pid
FOR XML AUTO
```

```
<Person pid="1" Name="John Higgins" YoB="1975">
    <Vehicle model="Cherry" brand="NISSAN" licencenumber="ABC123" Colour="black" />
</Person>
<Person pid="2" Name="Stephen Hendry" YoB="1973">
    <Vehicle model="Forza" brand="FIAT" licencenumber="CCD457" Colour="blue" />
</Person>
<Person pid="1" Name="John Higgins" YoB="1975">
    <Vehicle model="Cherry" brand="NISSAN" licencenumber="TYD226" Colour="black" />
</Person>
```

SQL Server - FOR XML AUTO

```
SELECT model, pid, Name, brand, yearofbirth YoB,
            licencenumber, color AS Colour
FROM Person, Car AS Vehicle
WHERE pid < 3 AND owner = pid
FOR XML AUTO
```

```
<Vehicle model="Cherry" brand="NISSAN" licencenumber="ABC123" Colour="black">
    <Person pid="1" Name="John Higgins" YoB="1975" />
</Vehicle>
<Vehicle model="Forza" brand="FIAT" licencenumber="CCD457" Colour="blue">
    <Person pid="2" Name="Stephen Hendry" YoB="1973" />
</Vehicle>
<Vehicle model="Cherry" brand="NISSAN" licencenumber="TYD226" Colour="black">
    <Person pid="1" Name="John Higgins" YoB="1975" />
</Vehicle>
```


SQL Server - FOR XML AUTO

- Subelement grouping is based on the ORDER BY clause

```
SELECT pid, Name, model, brand, yearofbirth YoB,
            licencenumber, color AS Colour
FROM Person, Car AS Vehicle
WHERE pid < 3 AND owner = pid
ORDER BY pid
FOR XML AUTO
```

```
<Person pid="1" Name="John Higgins" YoB="1975">
    <Vehicle model="Cherry" brand="NISSAN" licencenumber="ABC123" Colour="black" />
    <Vehicle model="Cherry" brand="NISSAN" licencenumber="TYD226" Colour="black" />
</Person>
<Person pid="2" Name="Stephen Hendry" YoB="1973">
    <Vehicle model="Forza" brand="FIAT" licencenumber="CCD457" Colour="blue" />
</Person>
```

SQL Server - FOR XML AUTO

- **Nest in order force the desired result**

```
SELECT Name, LicenceNr, Brand, Owner
FROM (SELECT DISTINCT color AS name FROM Car) AS Colour,
        (SELECT licencenumber AS licencenr, color, brand, name AS owner
        FROM Car, Person WHERE owner = pid) AS Vehicle
WHERE name = color
ORDER BY name
FOR XML AUTO
```

```
<Colour Name="black">
    <Vehicle LicenceNr="ABC123" Brand="NISSAN" Owner="John Higgins" />
    <Vehicle LicenceNr="RSQ199" Brand="NISSAN" Owner="Ronnie O'Sullivan" />
    <Vehicle LicenceNr="TYD226" Brand="NISSAN" Owner="John Higgins" />
</Colour>
<Colour Name="blue">
    <Vehicle LicenceNr="CCD457" Brand="FIAT" Owner="Stephen Hendry" />
    <Vehicle LicenceNr="ROO197" Brand="SAAB" Owner="Ken Doherty" />
</Colour>
<Colour Name="green">
    <Vehicle LicenceNr="DKL998" Brand="SAAB" Owner="Matthew Stevens" />
</Colour>
<Colour Name="red">
    <Vehicle LicenceNr="DAVIS1" Brand="VOLVO" Owner="Steve Davis" />
    <Vehicle LicenceNr="PTF357" Brand="VOLVO" Owner="Steve Davis" />
    <Vehicle LicenceNr="WID387" Brand="FIAT" Owner="Matthew Stevens" />
</Colour>
```


SQL Server - FOR XML AUTO

- **Supports ROOT, TYPE and ELEMENTS**

```
SELECT pid, Name, Brand, Model, yearofbirth AS YoB, LicenceNumber, color AS Colour
FROM Person, Car AS Vehicle
WHERE pid < 2 AND owner = pid
ORDER BY pid
FOR XML AUTO, ROOT, TYPE, ELEMENTS
```

```
<root>
    <Person>
        <pid>1</pid>
        <Name>John Higgins</Name>
        <YoB>1975</YoB>
        <Vehicle>
            <Brand>NISSAN</Brand>
            <Model>Cherry</Model>
            <LicenceNumber>ABC123</LicenceNumber>
            <Colour>black</Colour>
        </Vehicle>
        <Vehicle>
            <Brand>NISSAN</Brand>
            <Model>Cherry</Model>
            <LicenceNumber>TYD226</LicenceNumber>
            <Colour>black</Colour>
        </Vehicle>
    </Person>
</root>
```

SQL Server - FOR XML PATH

- More flexible than RAW and AUTO
  - Possible to mix elements and attributes
  - Manual nesting
- Column aliases in the SELECT clause are interpreted as XPath expressions
  - Default: similar to RAW, ELEMENTS

```
SELECT licencenumber AS LicenceNr, Color, Brand, name AS Owner
FROM Car, Person
WHERE owner = pid
FOR XML PATH
```

```
SELECT licencenumber AS LicenceNr, Color, Brand, name AS Owner
FROM Car, Person
WHERE owner = pid
FOR XML RAW, ELEMENTS
```


SQL Server - FOR XML PATH

```
SELECT licencenumber AS "@LicenceNr", color AS "@Colour",
        brand AS "@Brand", name AS Owner
FROM Car, Person
WHERE owner = pid AND owner < 3
FOR XML PATH ('Vehicle')
```

```
<Vehicle LicenceNr="ABC123" Colour="black" Brand="NISSAN">
        <Owner>John Higgins</Owner>
</Vehicle>
<Vehicle LicenceNr="CCD457" Colour="blue" Brand="FIAT">
        <Owner>Stephen Hendry</Owner>
</Vehicle>
<Vehicle LicenceNr="TYD226" Colour="black" Brand="NISSAN">
        <Owner>John Higgins</Owner>
</Vehicle>
```

SQL Server - FOR XML PATH

```
SELECT licencenumber AS "@LicenceNr", color AS "@Colour",
       brand AS "Type/@Brand", model AS "Type/@Model",
       name AS "Owner/@Name", pid AS "Owner/@PID"
FROM Car, Person
WHERE owner = pid AND owner < 3
FOR XML PATH ('Vehicle')
```

```
<Vehicle LicenceNr="ABC123" Colour="black">
       <Type Brand="NISSAN" Model="Cherry" />
       <Owner Name="John Higgins" PID="1" />
</Vehicle>
<Vehicle LicenceNr="CCD457" Colour="blue">
       <Type Brand="FIAT" Model="Forza" />
       <Owner Name="Stephen Hendry" PID="2" />
</Vehicle>
<Vehicle LicenceNr="TYD226" Colour="black">
       <Type Brand="NISSAN" Model="Cherry" />
       <Owner Name="John Higgins" PID="1" />
</Vehicle>
```


SQL Server - FOR XML PATH

- Use * to create a text node (without extra element)

```
SELECT name "*", ' owns ' "*",
       (SELECT COUNT(*) FROM Car WHERE owner = pid) "*", ' cars' "*"
FROM Person
FOR XML PATH ('Statement'), ROOT ('Info')
```

```
<Info>
    <Statement>John Higgins owns 2 cars</Statement>
    <Statement>Stephen Hendry owns 1 cars</Statement>
    <Statement>Matthew Stevens owns 2 cars</Statement>
    <Statement>Ronnie O'Sullivan owns 1 cars</Statement>
    <Statement>Ken Doherty owns 1 cars</Statement>
    <Statement>Steve Davis owns 2 cars</Statement>
    <Statement>Paul Hunter owns 0 cars</Statement>
    <Statement>Neil Robertson owns 0 cars</Statement>
</Info>
```

SQL Server - FOR XML PATH

- Grouping requires nesting
  - ORDER BY does not have the same effect as with AUTO
  - Use TYPE in the nested statement to return XML

```
SELECT color AS "@name",
       (SELECT licencenumber AS "@LicenceNr", brand AS "@Brand",
               model AS "@Model", name AS "Owner/@Name"
        FROM Car, Person
        WHERE owner = pid AND color = ct.color
        FOR XML PATH ('Vehicle'), TYPE) AS "*"
FROM (SELECT DISTINCT color FROM Car WHERE color <> 'black') AS ct
FOR XML PATH ('Colour'), ROOT ('CarsByColour')
```

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SQL Server - FOR XML PATH

```
<CarsByColour>
    <Colour name="blue">
        <Vehicle LicenceNr="CCD457" Brand="FIAT" Model="Forza">
            <Owner Name="Stephen Hendry" />
        </Vehicle>
        <Vehicle LicenceNr="ROO197" Brand="SAAB" Model="900i">
            <Owner Name="Ken Doherty" />
        </Vehicle>
    </Colour>
    <Colour name="green">
        <Vehicle LicenceNr="DKL998" Brand="SAAB" Model="9000C">
            <Owner Name="Matthew Stevens" />
        </Vehicle>
    </Colour>
    <Colour name="red">
        <Vehicle LicenceNr="DAVIS1" Brand="VOLVO" Model="V90">
            <Owner Name="Steve Davis" />
        </Vehicle>
        <Vehicle LicenceNr="PTF357" Brand="VOLVO" Model="V70">
            <Owner Name="Steve Davis" />
        </Vehicle>
        <Vehicle LicenceNr="WID387" Brand="FIAT" Model="Nova">
            <Owner Name="Matthew Stevens" />
        </Vehicle>
    </Colour>
</CarsByColour>
```

SQL Server - FOR XML

- NULL causes the node to not get created
  - With the keyword XSINIL (after ELEMENTS) a node will be created with the attribute xsi:nil="true"
- The keywords XMLDATA and XMLSCHEMA generate a schema for the result
  - Quite limited
- Use '' as element name to eliminate a level
- Use WITH XMLNAMESPACES (before the SELECT clause) to define namespaces
  - WITH XMLNAMESPACES ('nsuri' AS nsalias)
  - WITH XMLNAMESPACES (DEFAULT 'nsuri')

SQL Server - value()

- Method that evaluates an XQuery statement and returns a value
  - XML-object.value(xquery, data type)
  - xquery must always give one value/node. Use [1] if the result could theoretically be a sequence
    - » //employment[1]/@employer
      must be specified as
      (//employment[1]/@employer)[1]
      or
      (//employment)[1]/@employer

```
SELECT name, employments.value('(//employment[1]/@employer)[1]', 'varchar(10)')
FROM Person
WHERE pid < 4
```

John Higgins	ABB
Stephen Hendry	ABB
Matthew Stevens	UPC

SQL Server - query()

- Evaluates an XQuery statement and returns XML

```
SELECT name, employments.query('//employment[1]')
FROM Person
WHERE pid < 4
```

John Higgins	<employment startdate="2001-08-20" enddate="2009-02-28" employer="ABB" />
Stephen Hendry	<employment startdate="2002-08-20" enddate="2003-06-30" employer="ABB" />
Matthew Stevens	<employment startdate="2003-01-10" employer="UPC" />

```
SELECT name, employments.query('for $x in //employment[@employer="ABB"]
                                return element X {$x/@startdate}')
FROM Person
WHERE pid < 4
```

John Higgins	<X startdate="2001-08-20" />
Stephen Hendry	<X startdate="2002-08-20" /><X startdate="2006-11-01" />
Matthew Stevens	

SQL Server - value() vs query()

```
SELECT name, employments.query('count(//employment)'),
             employments.query('count(distinct-values(//@employer))')
FROM Person
WHERE pid < 4
```

```
SELECT name, employments.value('count(//employment)', 'int'),
             employments.value('count(distinct-values(//@employer))', 'int')
FROM Person
WHERE pid < 4
```

John Higgins	2	2
Stephen Hendry	3	2
Matthew Stevens	1	1

The result of the method query is XML

SQL Server - nodes()

- Converts a sequence of nodes to a table
  - One column
  - Every row corresponds to one node
  - The result is a relative node position in the original XML object
  - Can be used together with the keywords CROSS (or OUTER) APPLY (in order to use a column in the FROM clause)
  - Corresponds to SQL/XML:s XMLTABLE

```
SELECT name, c.query('.'), c.value('@employer', 'varchar(10)')
FROM Person CROSS APPLY employments.nodes('//employment') AS X(c)
WHERE pid < 4
```

John Higgins	<employment startdate="2001-08-20" enddate="2009-02-28" employer="ABB" />	ABB
John Higgins	<employment startdate="2009-04-15" employer="UPC" />	UPC
Stephen Hendry	<employment startdate="2002-08-20" enddate="2003-06-30" employer="ABB" />	ABB
Stephen Hendry	<employment startdate="2003-08-01" employer="UPC" />	UPC
Stephen Hendry	<employment startdate="2006-11-01" employer="ABB" />	ABB
Matthew Stevens	<employment startdate="2003-01-10" employer="UPC" />	UPC

SQL Server - nodes() & CROSS APPLY

```
SELECT name, c.query('.')
FROM Person CROSS APPLY
                employments.nodes('//employment[not(@enddate)]') AS X(c)
```

John Higgins	<employment startdate="2009-04-15" employer="UPC" />
Stephen Hendry	<employment startdate="2003-08-01" employer="UPC" />
Stephen Hendry	<employment startdate="2006-11-01" employer="ABB" />
Matthew Stevens	<employment startdate="2003-01-10" employer="UPC" />
Ronnie O'Sullivan	<employment startdate="2010-08-15" employer="STG" />
Ken Doherty	<employment startdate="2008-06-02" employer="STG" />
Steve Davis	<employment startdate="2009-02-01" employer="FFD" />
Steve Davis	<employment startdate="2009-02-01" employer="XAB" />
Neil Robertson	<employment startdate="2008-11-20" employer="ABB" />

SQL Server - nodes() & OUTER APPLY

```
SELECT name, c.query('.')
FROM Person OUTER APPLY
                employments.nodes('//employment[not(@enddate)]') AS X(c)
```

John Higgins	<employment startdate="2009-04-15" employer="UPC" />
Stephen Hendry	<employment startdate="2003-08-01" employer="UPC" />
Stephen Hendry	<employment startdate="2006-11-01" employer="ABB" />
Matthew Stevens	<employment startdate="2003-01-10" employer="UPC" />
Ronnie O'Sullivan	<employment startdate="2010-08-15" employer="STG" />
Ken Doherty	<employment startdate="2008-06-02" employer="STG" />
Steve Davis	<employment startdate="2009-02-01" employer="FFD" />
Steve Davis	<employment startdate="2009-02-01" employer="XAB" />
Paul Hunter	NULL
Neil Robertson	<employment startdate="2008-11-20" employer="ABB" />

SQL Server - exist()

- Evaluates an XQuery statement and returns
  - 1 if the result was not empty
  - 0 if the result was empty
  - NULL if the XML object was NULL

```
SELECT name
FROM Person
WHERE employments.exist('//employment[@employer="ABB"]') = 1
```

John Higgins
Stephen Hendry
Ken Doherty
Steve Davis
Neil Robertson

SQL Server - modify()

- Changes an XML object
  - Does not return anything
- Supported DML operations
  - insert
  - delete
  - replace value of
- Automatic validation for typed XML
- Used only in the SET clause of UPDATE statements
  - or with an object in a variable

SQL Server - modify() - insert

- Add new nodes
  - as first
  - as last
  - into
  - after
  - before
- The nodes can be created, deserialized or retrieved from a variable.

```
UPDATE Person
SET employments.modify('insert <employment startdate="2011-11-12"
employer="KFC"/> as last into /root[1]')
WHERE pid = 6
```

SQL Server - modify() - insert

```
UPDATE Person
SET employments.modify('insert <!-- new employment added --> before
(/root/employment[@employer="KFC"][@startdate="2011-11-12"])[1]')
WHERE pid = 6
```

```
UPDATE Person
SET employments.modify('insert attribute enddate {"2012-04-12"} into
(/root/employment[@employer="KFC"][@startdate="2011-11-12"])[1]')
WHERE pid = 6
```

if the attribute startdate is xs:date (in the XML Schema for typed XML):

[@startdate= "2011-11-12" cast as xs:date?]

or

[@startdate= xs:date("2011-11-12")]

SQL Server - modify() - delete

- Removes nodes that match an XPath expression
  - The root node may not be removed
  - Wildcards are allowed

```
UPDATE Person
SET employments.modify('delete
      /root/employment[@employer="KFC"]')
WHERE pid = 6
```

```
UPDATE Person
SET employments.modify('delete //comment()')
WHERE pid = 6
```

SQL Server - modify() - replace

- Replaces the value of one node
  - replace value of xpath-expression with new-value

```
UPDATE Person
SET employments.modify('
replace value of (/root/employment[@employer="ABB"]/@startdate)[1]
with "2001-01-04"')
WHERE pid = 6
```

For typed XML:

```
UPDATE person
SET employments.modify('
replace value of (/root/employment[@employer="ABB"]/@startdate)[1]
with xs:date("2001-01-04")')
WHERE pid = 6
```


SQL Server - XQuery

- The methods query, nodes, etc. require an XML object
- In order to execute XQuery independently of tables, use an XML object in a variable:

```
DECLARE @x xml
SET @x=''
SELECT @x.query('for $a in (2,3,4), $b in (5,6,7)
                 where $a+$b = 9
                 return element X {$a*$b}')
```

```
<X>14</X><X>18</X><X>20</X>
```

Or:

```
SELECT CONVERT(XML, '').query(…)
```

SQL Server - sql:column

- SQL Server-specific XQuery function
  - Makes a column value available to XQuery

```
SELECT employments.query('element Person {attribute
  age {2024-sql:column("yearofbirth")}, attribute name
  {sql:column("name")}}')
FROM Person
```

```
<Person age="49" name="John Higgins" />
<Person age="51" name="Stephen Hendry" />
<Person age="42" name="Matthew Stevens" />
<Person age="44" name="Ronnie O'Sullivan" />
<Person age="50" name="Ken Doherty" />
<Person age="64" name="Steve Davis" />
<Person age="41" name="Paul Hunter" />
<Person age="42" name="Neil Robertson" />
```


SQL Server - sql:column

```
SELECT name, employments.query('
        for $e in //employment
        let $y := sql:column("p.yearofbirth"),
                $sy := substring($e/@startdate, 1, 4) cast as xs:integer?
        return element Job {attribute age {$sy - $y},  $e/@employer}
                                                ')
FROM Person p
WHERE pid = 2
```

```
Stephen Hendry      <Job age="29" employer="ABB" />
                    <Job age="30" employer="UPC" />
                    <Job age="33" employer="ABB" />
```

SQL Server does not support many XPath/XQuery functions, so we are force to use substring and cast (or number after substring) instead of year-from-date

SQL Server - sql:variable

- SQL Server-specific XQuery function
  - Makes an SQL variable available in XQuery

```
DECLARE @x XML
SET @x = ''
DECLARE @v VARCHAR(10)
SET @v = 'Course'
SELECT @x.query('for $x in (1,2,3)
                 return element X {sql:variable("@v"), $x}')
```

```
<X>Course 1</X><X>Course 2</X><X>Course 3</X>
```


SQL Server - combinations

- Almost everything can be combined.

```
SELECT name AS "@Namn", employments.query('
                        for $e in //employment
                        let $y := sql:column("p.yearofbirth"),
                        $sy := substring($e/@startdate, 1, 4) cast as xs:integer?
                        return element Job {attribute Age {$sy - $y},
                        attribute Company  {$e/@employer}}')
FROM Person p
WHERE pid < 3
FOR XML PATH ('Person'), ROOT ('People')
```

```
<People>
    <Person Namn="John Higgins">
        <Job Age="26" Company="ABB" />
        <Job Age="34" Company="UPC" />
    </Person>
    <Person Namn="Stephen Hendry">
        <Job Age="29" Company="ABB" />
        <Job Age="30" Company="UPC" />
        <Job Age="33" Company="ABB" />
    </Person>
</People>
```

SQL Server - combinations

```
SELECT (SELECT name AS "@Name", COUNT(*) AS "@NrOfCars",
               jobcount AS "@NrOfJobs"
        FROM (SELECT pid, name,
               employments.value('count(//employment)', 'integer') as jobcount
               FROM Person) AS p, Car
        WHERE pid = owner
        GROUP BY name, jobcount
        FOR XML PATH ('Person'),
               ROOT ('People'),
               TYPE).query('element Root {//Person[@NrOfCars = 1]}')
```

```
<Root>
  <Person Name="Ronnie O'Sullivan" NrOfCars="1" NrOfJobs="2" />
  <Person Name="Stephen Hendry" NrOfCars="1" NrOfJobs="3" />
  <Person Name="Ken Doherty" NrOfCars="1" NrOfJobs="5" />
</Root>
```


SQL Server & JSON

- FOR JSON
  - Similar to FOR XML
  - PATH and AUTO
- Functions
  - JSON_VALUE, JSON_QUERY, JSON_MODIFY, JSON_PATH_EXISTS
- OPENJSON
  - Similar to OPENXML

Summary

- SQL Server does not follow the SQL standard
  - No functions
  - Maybe in the future (all SQL/XML keywords are reserved words)
- Limited support for XQuery 1 and XPath
- Still possible to achieve approximately the same functionality

What to do next

- Quiz about SQL Server & SQLXML (Quiz 8)
- Introduction to SQL Server & XML (compendium)
  - Introduction to SQL Server and SQL Server Management Studio
  - Examples
- Assignment 8 (SQL Server & XML)