NDBI001: **Query Languages I**

http://www.ksi.mff.cuni.cz/~svoboda/courses/211-NDBI001/

Lecture 8

SQL/XML

Martin Svoboda
martin.svoboda@matfyz.cuni.cz

9. 11. 2021

Charles University, Faculty of Mathematics and Physics

Introduction

- **SQL/XML**
  - **Extension to SQL for XML data**
    - XML Datatype
    - Constructs
      - Functions, constructors, mappings, XQuery embedding, …
- Standards
  - **SQL:2011-14** (ISO/IEC 9075-14:2011)
    - Older versions 2003, 2006, 2008

Example

- **Table**: books

id	catalogue	title	details	language
1	c1	Red	<author>John</author> <author>Peter</author>	en
2	c1	Green	<price>25</price>	NULL
3	c2	Blue	<author>John</author>	en

- **Table**: languages

code	name
en	English
cs	Czech

Example

- **Query**

```
SELECT
   id,
   XMLELEMENT(
      NAME "book",
      XMLELEMENT(NAME "title", title),
      details
   ) AS book
FROM books
WHERE (language = "en")
ORDER BY title DESC
```

Example

- **Result**

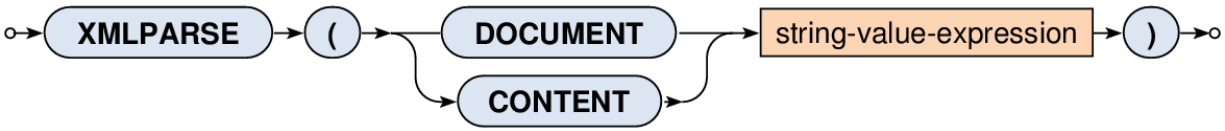
id	book
3	<book> <title>Blue</title> <author>John</author> </book>
1	<book> <title>Red</title> <author>John</author> <author>Peter</author> </book>

XML Datatype

- Traditional types
  - BLOB, CLOB, VARCHAR, …
- **Native XML type**
  - Collection of information items
    - Based on XML Information Set (**XML Infoset**)
      - Elements, attributes, processing instructions, …
      - But we also allow fragments without exactly one root element
        - » This means that XML values may not be XML documents
  - NULL

Parsing XML Values

- XMLPARSE
  - **Creates an XML value from a string**
    - DOCUMENT – well-formed document with exactly one root
    - CONTENT – well-formed fragment

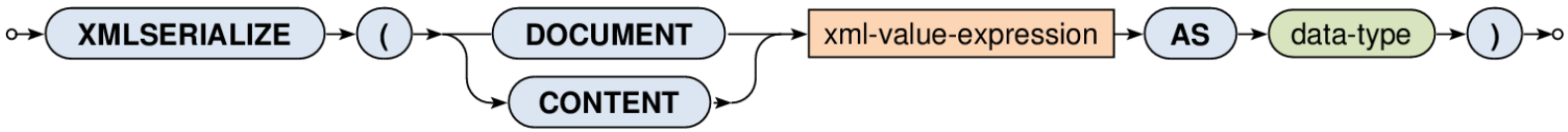



```
SELECT XMLPARSE (
   DOCUMENT "<book><title>Red</title></book>"
) AS result
```

result
<book> <title>Red</title> </book>

Serializing XML Values

- XMLSERIALIZE
  - **Exports an XML value to a string**




```
SELECT
   id, title,
   XMLSERIALIZE(CONTENT details AS VARCHAR(100)) AS export
FROM books
```

id	title	export
1	Red	<author>John</author><author>Peter</author>
...	...	...

Well-Formedness Predicate

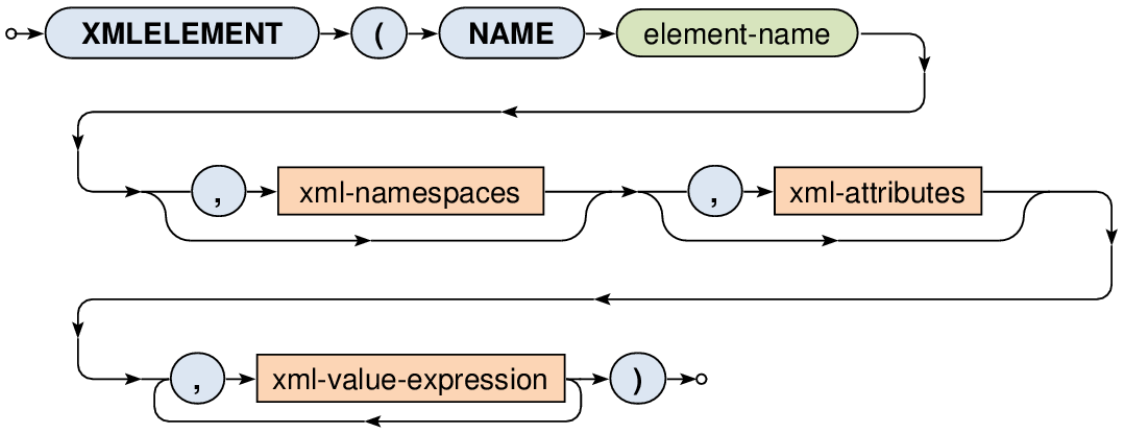
- IS DOCUMENT
  - **Tests whether an XML value is an XML document**
    - Returns `TRUE` if there is right one root element
    - Otherwise `FALSE`

Constructors

- Functions for construction of XML values…
  - **XMLELEMENT** – elements
  - **XMLNAMESPACES** – namespace declarations
  - **XMLATTRIBUTES** – attributes
  - **XMLCOMMENT** – comments
  - **XMLPI** – processing instructions
  - **XMLFOREST** – sequences of elements
  - **XMLCONCAT** – concatenations of values
  - **XMLAGG** – aggregates

Elements

- XMLELEMENT
  - **Creates an XML element** with a given name and…
    - optional **namespace declarations**
    - optional **attributes**
    - optional **element content**



Elements: Example 1

```
SELECT
   id,
   XMLELEMENT(NAME "book", title) AS result
FROM books
ORDER BY id
```

id	result
1	<book>Red</book>
2	<book>Green</book>
3	<book>Blue</book>

Elements: Example 2: Subelements

```
SELECT
   id,
   XMLELEMENT(
      NAME "book",
      XMLELEMENT(NAME "title", title),
      XMLELEMENT(NAME "language", language)
   ) AS records
FROM books
```

id	records
1	<book> **<title>Red</title>** **<language>en<language>** </book>
…	…

Elements: Example 3: Mixed Content

```
SELECT
   id,
   XMLELEMENT(
      NAME "info",
      "Book ", XMLELEMENT(NAME "title", title),
      " with identifier equal to", id, "."
   ) AS description
FROM books
```

id	description
1	<info> **Book <title>Red</title> with identifier equal to 1.** </info>
…	…

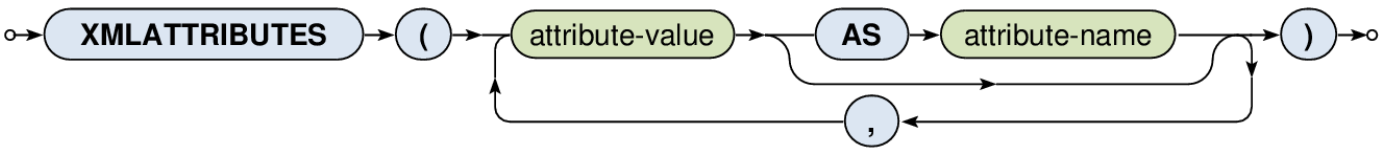
Elements: Example 4: Subqueries

```
SELECT
   id,
   XMLELEMENT(NAME "title", title) AS book,
   XMLELEMENT(
      NAME "language",
      (SELECT name FROM languages WHERE (code = language))
   ) AS description
FROM books
```

id	book	description
1	<title>Red</title>	<language>**English**</language>
…	…	…

Attributes

- XMLATTRIBUTES
  - **Creates a set of attributes**
  - Input: list of values
    - Each value must have an **explicit / implicit name**
      - It is used as a name for the given attribute
      - Implicit names can be derived, e.g., from column names
  - Output: XML value with a set of attributes



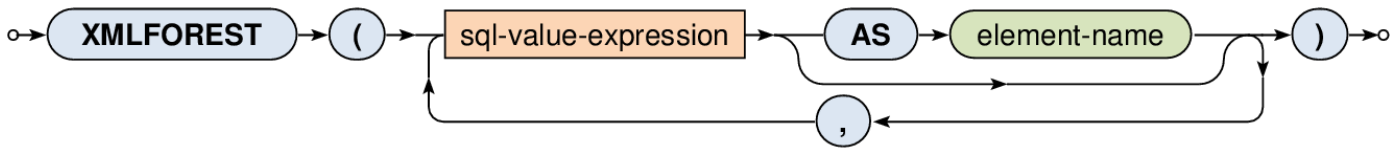
Attributes: Example

```
SELECT
   id,
   XMLELEMENT(NAME "book",
      XMLATTRIBUTES(
         language, catalogue AS "location"
      ),
      XMLELEMENT(NAME "title", title)
   ) AS book
FROM books
```

id	book
1	<book **language="en" location="c1"**> <title>Red</title> </book>
…	…

Element Sequences

- XMLFOREST
  - **Creates a sequence of XML elements**
  - Input: list of SQL values
    - Individual content expressions evaluated to `NULL` are ignored
    - If all the expressions are evaluated to `NULL`, then `NULL` is returned
  - Each content value must have an **explicit / implicit name**
    - It is used as a name for the given element
  - Output: XML value with a sequence elements



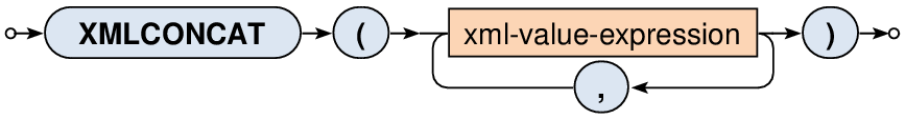
Element Sequences: Example

```
SELECT
   id,
   XMLFOREST(
      title, language, catalogue AS location
   ) AS book
FROM books
```

id	book
1	<title>Red</title> <language>en</language> <location>c1</location>
2	<title>Green</title> <location>c1</location>
…	…

Concatenation

- XMLCONCAT
  - **Creates a sequence from a list of values**
  - Input: list of XML values
    - Individual content expressions evaluated to `NULL` are ignored
    - If all the expressions are evaluated to `NULL`, then `NULL` is returned
  - Output: XML value with a sequence of values



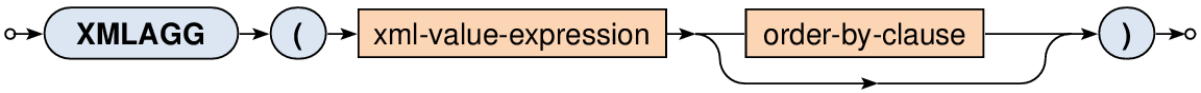
Concatenation: Example

```
SELECT
   id,
   XMLCONCAT(
      XMLELEMENT(NAME "book", title),
      details
   ) AS description
FROM books
```

id	description
1	<book>Red</book> <author>John</author> <author>Peter</author>
…	…

XML Aggregation

- XMLAGG
  - **Aggregates rows within a given super row**
    - I.e. acts as a standard aggregate function (like SUM, AVG, …)
  - Input: rows within a given super row
    - These rows can first be optionally sorted (**ORDER BY**)
    - For each row an XML value is generated as described
      - Individual rows evaluated to `NULL` values are ignored
    - All the generated XML values are then concatenated
      - If all the rows are evaluated to `NULL`, then `NULL` is returned
  - Output: XML value with a sequence of items



XML Aggregation: Example

```
SELECT
   catalogue,
   XMLAGG(
      XMLELEMENT(NAME "book", XMLATTRIBUTES(id),
         title)
      ORDER BY id
   ) AS list
FROM books
GROUP BY catalogue
```

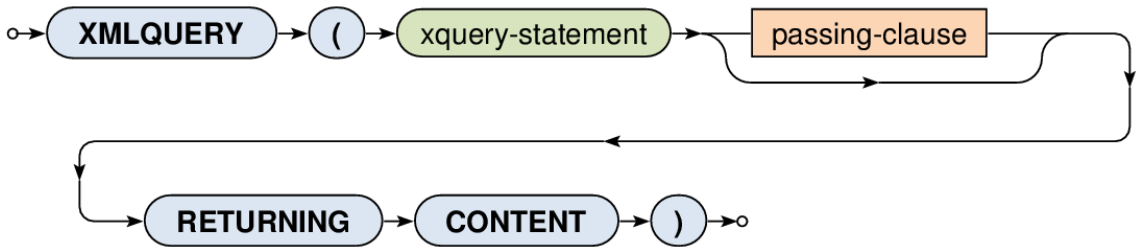
catalogue	list
c1	<book id="1">Red</book> <book id="2">Green</book>
c2	<book id="3">Blue</book>

Querying

- Query constructs
  - Based on XQuery language
  - **XMLQUERY** – returns query result
    - Usually in SELECT clauses
  - **XMLTABLE** – decomposes query result into a table
    - Usually in FROM clauses
  - **XMLEXISTS** – tests query result non-emptiness
    - Usually in WHERE clauses

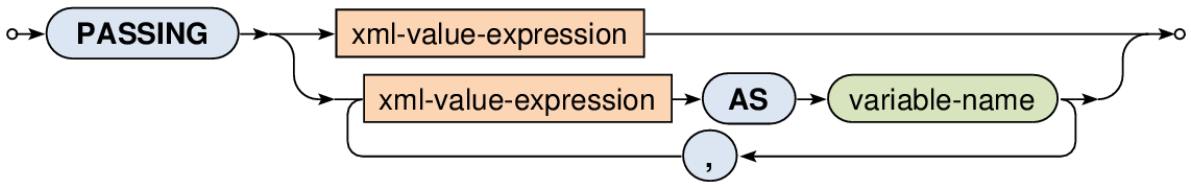
XQuery Statements

- XMLQUERY
  - **Evaluates an XQuery statement and returns its result**
  - Input:
    - XML values declared in an optional **PASSING** clause
  - Output: XML value



XQuery Statements

- XMLQUERY
  - Input data
    - When **only one input value** is specified…
      - its content is accessible via `/` inside the XQuery statement
    - When **one or more named variables** are specified…
      - their content is accessible via `$variable-name/`



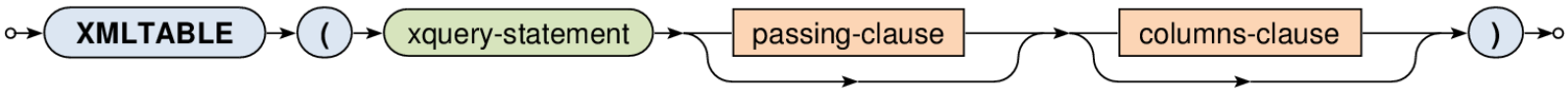
XQuery Statements: Example

```
SELECT
   id, title,
   XMLQUERY(
      "<authors>{ count($data/author) }</authors>"
      PASSING details AS data
      RETURNING CONTENT
   ) AS description
FROM books
```

id	title	description
1	Red	<authors>2</authors>
…	…	…

XML Tables

- XMLTABLE
  - **Decomposes an XQuery result into a virtual table**
  - Output:
    - When **COLUMNS** clause is specified…
      - Table containing the XQuery result being shredded into individual rows and columns according to the description
    - Otherwise…
      - Table containing the XQuery result being shredded into individual rows with only one XML value column



XML Tables: Example 1

```
SELECT
   id, title, result.*
FROM
   books,
   XMLTABLE(
      "<authors>{ count($data/author) }</authors>"
      PASSING books.details AS data
   ) AS result
```

id	title	result
1	Red	<authors>2</authors>
…	…	…

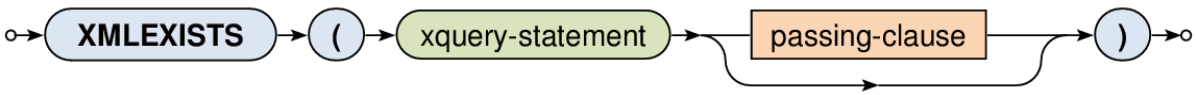
XML Tables: Example 2

```
SELECT
   id, title, result.count
FROM
   books,
   XMLTABLE(
      "<authors>{ count($data/author) }</authors>"
      PASSING books.details AS data
      COLUMNS
         count INTEGER PATH "authors/text()"
   ) AS result
```

id	title	count
1	Red	**2**
…	…	…

Exists Predicate

- XMLEXISTS
  - **Tests an XQuery statement result for non-emptiness**
  - Output: Boolean value
    - Returns `TRUE` for result sequences that are not empty
    - Otherwise `FALSE`



Exists Predicate: Example

```
SELECT books.*
FROM books
WHERE
   XMLEXISTS(
      "/author"
      PASSING details
   )
```

id	catalogue	title	details	language
1	c1	Red	<author>John</author> <author>Peter</author>	en
3	c2	Blue	<author>John</author>	en