Querying XML Documents

Paul Cotton, Microsoft

Jonathan Robie, Software AG

Unicode Conference

Jan 30, 2002

Organization of Presentation

- XML query history
- XML Query WG history, goals and status
- XML Query working drafts
- XQuery overview
- XQuery issues
- Questions

XML query history

- Early queries facilities for SGML
- 1998: “roll your own query language”
- Feb 1998: XQL proposal
  - http://metalab.unc.edu/xql
- Aug 1998: XML-QL submission
  - http://www.w3.org/TR/NOTE-xml-ql/
- Dec 1998: W3C QL’98 Workshop
  - http://www.w3.org/TandS/QL/QL98
- Nov 1999: XPath Recommendation
  - http://www.w3.org/TR/xpath

QL’98 candidate requirements

- QL’98 workshop summary
  - Candidate Requirements for XML Query, Paul Cotton and Ashok Malhotra, IBM
  - http://www.w3.org/TandS/QL/QL98/pp/queryreq.html
- See also:
  - Database Desiderata for an XML Query Language, David Maier, Oregon Graduate Institute
  - http://www.w3.org/TandS/QL/QL98/pp/maier.html

W3C XML Query WG - History

- July 1999: Working Group proposed as part of XML Activity Phase 3 rechartering
- Sept 1999: WG chartered and first F2F
- Currently 27 W3C member companies
- 15 F2F meetings and 88+ telcons so far
- Public WDs every three months
- Proposed recommendation(s)

W3C XML Query WG - Goals

- “The goal of the XML Query WG is to produce a data model for XML documents, a set of query operators on that data model, and a query language based on these query operators.”

W3C XML Query WG - Status

- Jan 2000: Requirements Working Draft
- May 2000: XML Query Data Model WD
- May 2000: Feedback on Schema Last Call
- Aug 2000: Revised Requirements Working Draft with Use Cases
- Dec 2000: XML Query Algebra WD
- Feb 2001: Revised Working Drafts
  - XML Query Requirements

    http://www.w3.org/TR/xmlquery-req

W3C XML Query WG - Status

- June 2001: Revised Working Drafts
  - XQuery 1.0: An XML Query Language
  - XML Query Use Cases
  - XML Query 1.0 and XPath 2.0 Data Model
  - XML Query 1.0 Formal Semantics
  - XML Syntax for XQuery 1.0: XQueryX
- August 2001
  - XML Query 1.0 and XPath 2.0 Functions and Operators
    http://www.w3.org/TR/query-operators

W3C XML Query WG - Status

- December 2001
  - XQuery 1.0: An XML Query Language
    http://www.w3.org/TR/xquery
  - XML Query Use Cases
    http://www.w3.org/TR/xmlquery-use-cases
  - XML Path Language (XPath) 2.0
    http://www.w3.org/TR/xpath20
  - XML Query 1.0 and XPath 2.0 Data Model
    http://www.w3.org/TR/query-datamodel/
  - XML Query 1.0 and XPath 2.0 Functions and Operators
    http://www.w3.org/TR/query-operators
- Next publication status
- WG Charter status

XML Query Requirements WD

- General Requirements
  - Non-procedural query language
  - XML syntax for query language but also a readable syntax
  - Protocol independent
  - Standard error conditions
  - Future support for updates
- XML Query Data Model Requirements
  - Built on XML Infoset and PSVI
  - Namespace aware
  - Support for XML Schema data types
  - Support for inter- and intra- document references

XML Query Requirements WD

- XML Query Functionality
  - Operators on all data types
  - Text operators across element boundaries
  - Support for hierarchy and sequence
  - Ability to combine data from different locs
  - Aggregation and sorting
  - Combination of operators including queries as operands
  - Support for NULL/empty values
  - Structural preservations
  - Identity preservation
  - Operations on names
  - Operations on “schemas”
  - Extensibility
  - Closure

XML Query Use Cases WD

- Use Case Organization
  - Description, DTD/Schema, Input Data, Queries and Results
- Current Use Cases
  - "XMP": Experiences and Exemplars
  - "TREE": Queries that preserve hierarchy
  - "SEQ" - Queries based on Sequence
  - "R" - Access to Relational Data
  - "TEXT": Full-text Search
  - "NS" - Queries Using Namespaces
  - "PARTS" - Recursive Parts Explosion
  - "REF" - Queries based on References

XML Query 1.0 Data Model WD

- Defines what information is available to an XML Query or XPath 2.0 processor
- Published jointly with XSL Working Group
- Infoset plus the following:
  - Support for XML Schema data types (PSVI)
  - Support for document collections
  - Support for references
- Node-labelled tree constructor model with node identity
- Mapping from Infoset to Query Data Model uses Infoset terminology and shown by example

XML Query 1.0 Formal Semantics WD

- XML Query Formal Semantics is used:
  - to define XQuery semantics
  - to support query optimization
- FS defines both static and dynamic semantics
  - static semantics are presented as type inference rules, which relate XQuery/FS expressions to types
  - dynamic, or operational, semantics are presented as value inference rules, which relate XQuery/FS expressions to values in the XML Query Data Model

XQuery: A Query Language for XML

- XQuery is a functional language in which a query is represented as an expression
- XQuery expressions can be nested with full generality
- The input and output of an XQuery are instances of the XML Query Data Model
- Based on OQL, SQL, XML-QL, XPath
- Readable vs. XML syntax

XQueryX

- XQueryX is an XML representation of an XQuery
- It was created by mapping the productions of the XQuery abstract syntax directly into XML productions
- XQueryX useful to enable:
  - Parser reuse
  - Queries on queries
  - Generation of queries
  - Embedding of queries in XML documents

XQuery Expressions

- XQuery expressions
  - Path expressions
  - Element constructors
  - FLWR expressions
  - Expressions involving operators and functions
  - Conditional expressions
  - Quantified expressions
  - List constructors
  - Expressions that test or modify datatypes

XQuery Path Expressions

- Based on abbreviated syntax of XPath 1.0
- **(Q1) In the second chapter of the document named "zoo.xml", find the figure(s) with caption “Tree Frogs”.**

```
document("zoo.xml")/chapter[2]//figure[caption =
 "Tree Frogs"]
```

- Extended with:
  - a new dereference operator
  - a range predicate
- **(Q3) Find captions of figures that are referenced by <figref> elements in the chapter of "zoo.xml" with title "Frogs".**

```
document("zoo.xml")/chapter[title = "Frogs"]
//figref/@refid->fig/caption
```

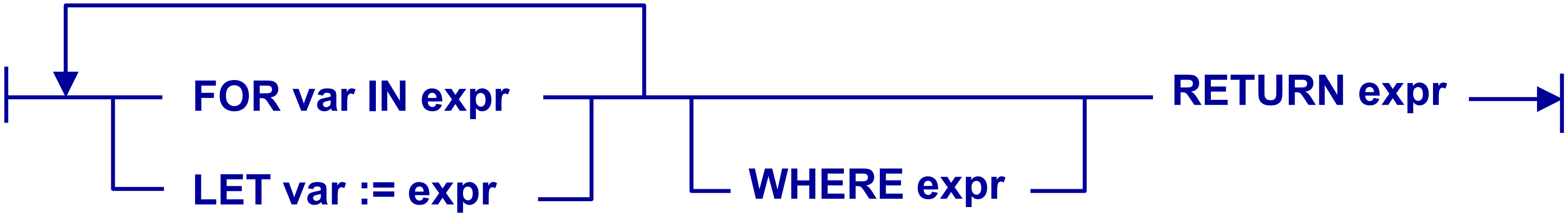
XQuery Element Constructors

- XQuery element constructor consists of a start tag and an end tag, enclosing an optional list of expressions that provide the content of the element.
- **(Q8) Generate an <emp>element that has an "empid" attribute. The value of attribute and the content of the are specified by variables that are bound in other parts of the query.**

```
 <emp empid = {$id}>
     {$name}
     {$job}
</emp>
```

XQuery FLWR Expressions

- A FLWR expression binds some expressions, applies a predicate, and constructs a new result.



FOR and LET clauses generate a list of tuples of bound expressions, preserving document order.

WHERE clause applies a predicate, eliminating some of the tuples

RETURN clause is executed for each surviving tuple, generating an ordered list of outputs

XQuery FLWR Expressions

- **(Q11) List the titles of books published by Morgan Kaufmann in 1998.**

```
FOR $b IN document("bib.xml")//book
WHERE $b/publisher = "Morgan Kaufmann"
    AND $b/year = "1998"
RETURN $b/title
```

- **(Q12) List each publisher and the average price of its books.**

```
FOR $p IN distinct(document("bib.xml")//publisher)
LET $a := avg(document("bib.xml")
    /book[publisher = $p]/price)
RETURN
    <publisher>
        <name> {$p/text()} </name>
        <avgprice> {$a} </avgprice>
    </publisher>
```

XQuery Operators and Functions

- Infix and prefix operators
- Parenthesized expressions
- Arithmetic and logical operators
- Sequence operators UNION, INTERSECT and EXCEPT
- Functions can be defined in XQuery

XQuery Operators and Functions

- **(Q25) Find the maximum depth of the document named "partlist.xml."**

```
NAMESPACE xsd="http://www.w3.org/2001/XMLSchema-datatypes"

FUNCTION depth(ELEMENT $e) RETURNS xsd:integer
{
    -- An empty element has depth 1
    -- Otherwise, add 1 to max depth of children
    IF empty($e/*) THEN 1
    ELSE max(depth($e/*)) + 1
}

depth(document("partlist.xml"))
```

XQuery Conditional Expressions

- IF THEN ELSE construct
- **(Q21) Make a list of holdings, ordered by title. For journals, include the editor, and for all other holdings, include the author**.

```
FOR $h IN //holding
RETURN
    <holding>
        {$h/title,
         IF $h/@type = "Journal" THEN
            $h/editor
         ELSE
            $h/author
        }
    </holding> SORTBY (title)
```

XQuery Quantified Expressions

- Existential and Universal quantifiers
- **(Q22) Find titles of books in which both sailing and windsurfing are mentioned in the same paragraph.**

```
FOR $b IN //book
WHERE SOME $p IN $b//para SATISFIES
    contains($p, "sailing")
    AND contains($p, "windsurfing")
RETURN $b/title
```

- **(Q23) Find titles of books in which sailing is mentioned in every paragraph.**

```
FOR $b IN //book
WHERE EVERY $p IN $b//para SATISFIES
    contains($p, "sailing")
RETURN $b/title
```

Sequence-related Operators

- A sequence may be constructed by enclosing zero or more expressions separated by commas.
- For example: ($x, $y, $z) denotes a sequence containing three members represented by variables
- PRECEDES and FOLLOWS boolean functions
- () denotes an empty sequence.

XQuery Operators on Data Types

- INSTANCEOF returns True if its first operand is an instance of the type named in its second operand
- CAST is used to convert a value from one data type to another
- TREAT causes the query processor to treat an expression as though its data type were a subtype of its static type

XQuery Issues

- Alignment of XQuery/XPath
- Revised version of Formal Semantics and XQueryX
- Update language – now or later?
- Internationalization (I18N) issues
- Support for full-text retrieval

Internationalization Issues

- Internationalization issues
  - string operations
  - comparison and sorting of data
  - specification of collations
  - default collation (user, query or schema?)
  - relationship xml:lang

Full-Text Issues

- Full-Text issues
  - history within WG
  - Library of Congress Use Case

    http://lcweb.loc.gov/crsinfo/xml/lc_usecases.html
  - related to I18N issues
  - portability versus interoperability
  - cross language definition of characters, words, sentences and paragraphs
  - relationship to SQL/MM Part 2: Full-Text

    ftp://sqlstandards.org/SC32/WG4/Progression_Documents/CD/cd-fulltext-2001-05.pdf

Early implementations

- CL-XML http://homepage.mac.com/james_anderson/XML/index.html
- Enosys Markets http://www.enosysmarkets.com/products/xq.html
- Fatdog http://www.fatdog.com/
- Kawa-Query http://www.gnu.org/software/kawa/xquery/
- IPSI-XQ http://xml.ipsi.fhg.de/xquerydemo
- Lucent http://db.bell-labs.com/galax/
- Kweelt http://db.cis.upenn.edu/Kweelt/
- Microsoft http://xqueryservices.com
- Software AG http://www.softwareag.com/developer/downloads/default.htm
- SourceForge http://sourceforge.net/projects/xquench/
- X-Hive http://www.x-hive.com/xquery
- XML Global http://www.xmlglobal.com
- and more …

Questions

- Today
- Later:
  pcotton@microsoft.com
  jonathan.robie@softwareag.com
- Feedback email list:
  www-xml-query-comments@w3.org
- Public email list:
  www-ql@w3.org