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Introduction to XQuery

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The best way to explain XQuery is to say that XQuery is to XML what SQL is to database tables.

XQuery is designed to query XML data - not just XML files, but anything that can appear as XML, including databases.

What You Should Already Know

Before you continue you should have a basic understanding of the following:

- HTML / XHTML
- XML / XML Namespaces
- XPath

If you want to study these subjects first, find the tutorials on our [Home page](#).

What is XQuery?

- XQuery is *the* language for querying XML data
- XQuery for XML is like SQL for databases
- XQuery is built on XPath expressions
- XQuery is supported by all the major database engines (IBM, Oracle, Microsoft, etc.)
- XQuery is a W3C Recommendation

XQuery is About Querying XML

XQuery is a language for finding and extracting elements and attributes from XML documents.

Here is an example of a question that XQuery could solve:

"Select all CD records with a price less than \$10 from the CD collection stored in the XML document called cd_catalog.xml"

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XQuery and XPath

XQuery 1.0 and XPath 2.0 share the same data model and support the same functions and operators. If you have already studied XPath you will have no problems with understanding XQuery.

You can read more about XPath in our [XPath Tutorial](#).

XQuery - Examples of Use

XQuery can be used to:

- Extract information to use in a Web Service
 - Generate summary reports
 - Transform XML data to XHTML
 - Search Web documents for relevant information
-

XQuery is a W3C Recommendation

XQuery is compatible with several W3C standards, such as XML, Namespaces, XSLT, XPath, and XML Schema.

XQuery 1.0 became a W3C Recommendation January 23, 2007.

To read more about the XQuery activity at W3C, please read our [W3C Tutorial](#).

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XQuery Example

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Let's try to learn some basic XQuery syntax by looking at an example.

The XML Example Document

We will use the following XML document in the examples below.

"books.xml":

```
<?xml version="1.0" encoding="ISO-8859-1"?>

<bookstore>

<book category="COOKING">
  <title lang="en">Everyday Italian</title>
  <author>Giada De Laurentiis</author>
  <year>2005</year>
  <price>30.00</price>
</book>

<book category="CHILDREN">
  <title lang="en">Harry Potter</title>
  <author>J K. Rowling</author>
  <year>2005</year>
  <price>29.99</price>
</book>

<book category="WEB">
  <title lang="en">XQuery Kick Start</title>
  <author>James McGovern</author>
  <author>Per Bothner</author>
  <author>Kurt Cagle</author>
  <author>James Linn</author>
  <author>Vaidyanathan Nagarajan</author>
  <year>2003</year>
  <price>49.99</price>
</book>

<book category="WEB">
```

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```
<title lang="en">Learning XML</title>
<author>Erik T. Ray</author>
<year>2003</year>
<price>39.95</price>
</book>

</bookstore>
```

[View the "books.xml" file in your browser.](#)

How to Select Nodes From "books.xml"?

Functions

XQuery uses functions to extract data from XML documents.

The doc() function is used to open the "books.xml" file:

```
doc("books.xml")
```

Path Expressions

XQuery uses path expressions to navigate through elements in an XML document.

The following path expression is used to select all the title elements in the "books.xml" file:

```
doc("books.xml")/bookstore/book/title
```

(/bookstore selects the bookstore element, /book selects all the book elements under the bookstore element, and /title selects all the title elements under each book element)

The XQuery above will extract the following:

```
<title lang="en">Everyday Italian</title>
<title lang="en">Harry Potter</title>
<title lang="en">XQuery Kick Start</title>
<title lang="en">Learning XML</title>
```

Predicates

XQuery uses predicates to limit the extracted data from XML documents.

The following predicate is used to select all the book elements under the bookstore element that have a price element with a value that is less than 30:

```
doc("books.xml")/bookstore/book[price<30]
```

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The XQuery above will extract the following:

```
<book category="CHILDREN">
  <title lang="en">Harry Potter</title>
  <author>J K. Rowling</author>
  <year>2005</year>
  <price>29.99</price>
</book>
```

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The XML Example Document

We will use the "books.xml" document in the examples below (same XML file as in the previous chapter).

[View the "books.xml" file in your browser.](#)

How to Select Nodes From "books.xml" With FLWOR

Look at the following path expression:

```
doc("books.xml")/bookstore/book[price>30]/title
```

The expression above will select all the title elements under the book elements that are under the bookstore element that have a price element with a value that is higher than 30.

The following FLWOR expression will select exactly the same as the path expression above:

```
for $x in doc("books.xml")/bookstore/book
where $x/price>30
return $x/title
```

The result will be:

```
<title lang="en">XQuery Kick Start</title>
<title lang="en">Learning XML</title>
```

With FLWOR you can sort the result:

```
for $x in doc("books.xml")/bookstore/book
where $x/price>30
order by $x/title
return $x/title
```

FLWOR is an acronym for "For, Let, Where, Order by, Return".

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The **for** clause selects all book elements under the bookstore element into a variable called \$x.

The **where** clause selects only book elements with a price element with a value greater than 30.

The **order by** clause defines the sort-order. Will be sort by the title element.

The **return** clause specifies what should be returned. Here it returns the title elements.

The result of the XQuery expression above will be:

```
<title lang="en">Learning XML</title>
<title lang="en">XQuery Kick Start</title>
```

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The XML Example Document

We will use the "books.xml" document in the examples below (same XML file as in the previous chapters).

[View the "books.xml" file in your browser.](#)

Present the Result In an HTML List

Look at the following XQuery FLWOR expression:

```
for $x in doc("books.xml")/bookstore/book/title
order by $x
return $x
```

The expression above will select all the title elements under the book elements that are under the bookstore element, and return the title elements in alphabetical order.

Now we want to list all the book-titles in our bookstore in an HTML list. We add and tags to the FLWOR expression:

```
<ul>
{
for $x in doc("books.xml")/bookstore/book/title
order by $x
return <li>{$x}</li>
}
</ul>
```

The result of the above will be:

```
<ul>
<li><title lang="en">Everyday Italian</title></li>
<li><title lang="en">Harry Potter</title></li>
<li><title lang="en">Learning XML</title></li>
<li><title lang="en">XQuery Kick Start</title></li>
</ul>
```

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Now we want to eliminate the title element, and show only the data inside the title element:

```
<ul>
{
for $x in doc("books.xml")/bookstore/book/title
order by $x
return <li>{data($x)}</li>
}
</ul>
```

The result will be (an HTML list):

```
<ul>
<li>Everyday Italian</li>
<li>Harry Potter</li>
<li>Learning XML</li>
<li>XQuery Kick Start</li>
</ul>
```

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In XQuery, there are seven kinds of nodes: element, attribute, text, namespace, processing-instruction, comment, and document (root) nodes.

XQuery Terminology

Nodes

In XQuery, there are seven kinds of nodes: element, attribute, text, namespace, processing-instruction, comment, and document (root) nodes. XML documents are treated as trees of nodes. The root of the tree is called the document node (or root node).

Look at the following XML document:

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<bookstore>
<book>
  <title lang="en">Harry Potter</title>
  <author>J K. Rowling</author>
  <year>2005</year>
  <price>29.99</price>
</book>
</bookstore>
```

Example of nodes in the XML document above:

```
<bookstore> (document node)

<author>J K. Rowling</author> (element node)

lang="en" (attribute node)
```

Atomic values

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Atomic values are nodes with no children or parent.

Example of atomic values:

```
J K. Rowling
```

```
"en"
```

Items

Items are atomic values or nodes.

Relationship of Nodes

Parent

Each element and attribute has one parent.

In the following example; the book element is the parent of the title, author, year, and price:

```
<book>
  <title>Harry Potter</title>
  <author>J K. Rowling</author>
  <year>2005</year>
  <price>29.99</price>
</book>
```

Children

Element nodes may have zero, one or more children.

In the following example; the title, author, year, and price elements are all children of the book element:

```
<book>
  <title>Harry Potter</title>
  <author>J K. Rowling</author>
  <year>2005</year>
  <price>29.99</price>
</book>
```

Siblings

Nodes that have the same parent.

In the following example; the title, author, year, and price elements are all siblings:

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```
<book>
  <title>Harry Potter</title>
  <author>J K. Rowling</author>
  <year>2005</year>
  <price>29.99</price>
</book>
```

Ancestors

A node's parent, parent's parent, etc.

In the following example; the ancestors of the title element are the book element and the bookstore element:

```
<bookstore>

<book>
  <title>Harry Potter</title>
  <author>J K. Rowling</author>
  <year>2005</year>
  <price>29.99</price>
</book>

</bookstore>
```

Descendants

A node's children, children's children, etc.

In the following example; descendants of the bookstore element are the book, title, author, year, and price elements:

```
<bookstore>

<book>
  <title>Harry Potter</title>
  <author>J K. Rowling</author>
  <year>2005</year>
  <price>29.99</price>
</book>

</bookstore>
```

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XQuery is case-sensitive and XQuery elements, attributes, and variables must be valid XML names.

XQuery Basic Syntax Rules

Some basic syntax rules:

- XQuery is case-sensitive
- XQuery elements, attributes, and variables must be valid XML names
- An XQuery string value can be in single or double quotes
- An XQuery variable is defined with a \$ followed by a name, e.g. \$bookstore
- XQuery comments are delimited by (: and :), e.g. (: XQuery Comment :)

XQuery Conditional Expressions

"If-Then-Else" expressions are allowed in XQuery.

Look at the following example:

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

Notes on the "if-then-else" syntax: parentheses around the if expression are required. else is required, but it can be just else ().

The result of the example above will be:

```
<adult>Everyday Italian</adult>
<child>Harry Potter</child>
<adult>Learning XML</adult>
<adult>XQuery Kick Start</adult>
```

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XQuery Comparisons

In XQuery there are two ways of comparing values.

1. General comparisons: =, !=, <, <=, >, >=
2. Value comparisons: eq, ne, lt, le, gt, ge

The difference between the two comparison methods are shown below.

Look at the following XQuery expressions:

```
$bookstore//book/@q > 10
```

The expression above returns true if any q attributes have values greater than 10.

```
$bookstore//book/@q gt 10
```

The expression above returns true if there is only one q attribute returned by the expression, and its value is greater than 10. If more than one q is returned, an error occurs.

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XQuery Adding Elements and Attributes

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The XML Example Document

We will use the "books.xml" document in the examples below (same XML file as in the previous chapters).

[View the "books.xml" file in your browser.](#)

Adding Elements and Attributes to the Result

As we have seen in a previous chapter, we may include elements and attributes from the input document ("books.xml) in the result:

```
for $x in doc("books.xml")/bookstore/book/title
order by $x
return $x
```

The XQuery expression above will include both the title element and the lang attribute in the result, like this:

```
<title lang="en">Everyday Italian</title>
<title lang="en">Harry Potter</title>
<title lang="en">Learning XML</title>
<title lang="en">XQuery Kick Start</title>
```

The XQuery expression above returns the title elements the exact same way as they are described in the input document.

We now want to add our own elements and attributes to the result!

Add HTML Elements and Text

Now, we want to add some HTML elements to the result. We will put the result in an HTML list - together with some text:

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```

<html>
<body>

<h1>Bookstore</h1>

<ul>
{
for $x in doc("books.xml")/bookstore/book
order by $x/title
return <li>{data($x/title)}. Category: {data($x/@category)}</li>
}
</ul>

</body>
</html>

```

The XQuery expression above will generate the following result:

```

<html>
<body>

<h1>Bookstore</h1>

<ul>
<li>Everyday Italian. Category: COOKING</li>
<li>Harry Potter. Category: CHILDREN</li>
<li>Learning XML. Category: WEB</li>
<li>XQuery Kick Start. Category: WEB</li>
</ul>

</body>
</html>

```

Add Attributes to HTML Elements

Next, we want to use the category attribute as a class attribute in the HTML list:

```

<html>
<body>

<h1>Bookstore</h1>

<ul>
{
for $x in doc("books.xml")/bookstore/book
order by $x/title
return <li class="{data($x/@category)}">{data($x/title)}</li>
}
</ul>

</body>

```

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```
</html>
```

The XQuery expression above will generate the following result:

```
<html>
<body>

<h1>Bookstore</h1>

<ul>
<li class="COOKING">Everyday Italian</li>
<li class="CHILDREN">Harry Potter</li>
<li class="WEB">Learning XML</li>
<li class="WEB">XQuery Kick Start</li>
</ul>

</body>
</html>
```

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XQuery Selecting and Filtering

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The XML Example Document

We will use the "books.xml" document in the examples below (same XML file as in the previous chapters).

[View the "books.xml" file in your browser.](#)

Selecting and Filtering Elements

As we have seen in the previous chapters, we are selecting and filtering elements with either a Path expression or with a FLWOR expression.

Look at the following FLWOR expression:

```
for $x in doc("books.xml")/bookstore/book
where $x/price>30
order by $x/title
return $x/title
```

- for - (optional) binds a variable to each item returned by the in expression
- let - (optional)
- where - (optional) specifies a criteria
- order by - (optional) specifies the sort-order of the result
- return - specifies what to return in the result

The for Clause

The for clause binds a variable to each item returned by the in expression. The for clause results in iteration. There can be multiple for clauses in the same FLWOR expression.

To loop a specific number of times in a for clause, you may use the **to** keyword:

```
for $x in (1 to 5)
return <test>{$x}</test>
```

Result:

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```
<test>1</test>
<test>2</test>
<test>3</test>
<test>4</test>
<test>5</test>
```

The **at** keyword can be used to count the iteration:

```
for $x at $i in doc("books.xml")/bookstore/book/title
return <book>{$i}. {data($x)}</book>
```

Result:

```
<book>1. Everyday Italian</book>
<book>2. Harry Potter</book>
<book>3. XQuery Kick Start</book>
<book>4. Learning XML</book>
```

It is also allowed with more than one in expression in the for clause. Use comma to separate each in expression:

```
for $x in (10,20), $y in (100,200)
return <test>x={$x} and y={$y}</test>
```

Result:

```
<test>x=10 and y=100</test>
<test>x=10 and y=200</test>
<test>x=20 and y=100</test>
<test>x=20 and y=200</test>
```

The let Clause

The let clause allows variable assignments and it avoids repeating the same expression many times. The let clause does not result in iteration.

```
let $x := (1 to 5)
return <test>{$x}</test>
```

Result:

```
<test>1 2 3 4 5</test>
```

The where Clause

The where clause is used to specify one or more criteria for the result:

```
where $x/price>30 and $x/price<100
```

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The order by Clause

The order by clause is used to specify the sort order of the result. Here we want to order the result by category and title:

```
for $x in doc("books.xml")/bookstore/book
order by $x/@category, $x/title
return $x/title
```

Result:

```
<title lang="en">Harry Potter</title>
<title lang="en">Everyday Italian</title>
<title lang="en">Learning XML</title>
<title lang="en">XQuery Kick Start</title>
```

The return Clause

The return clause specifies what is to be returned.

```
for $x in doc("books.xml")/bookstore/book
return $x/title
```

Result:

```
<title lang="en">Everyday Italian</title>
<title lang="en">Harry Potter</title>
<title lang="en">XQuery Kick Start</title>
<title lang="en">Learning XML</title>
```

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XQuery Functions

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XQuery 1.0, XPath 2.0, and XSLT 2.0 share the same functions library.

XQuery Functions

XQuery includes over 100 built-in functions. There are functions for string values, numeric values, date and time comparison, node and QName manipulation, sequence manipulation, Boolean values, and more. You can also define your own functions in XQuery.

XQuery Built-in Functions

The URI of the XQuery function namespace is:
<http://www.w3.org/2005/02/xpath-functions>

The default prefix for the function namespace is fn:.

Tip: Functions are often called with the fn: prefix, such as fn:string(). However, since fn: is the default prefix of the namespace, the function names do not need to be prefixed when called.

[The reference of all the built-in XQuery 1.0 functions is located in our XPath tutorial.](#)

Examples of Function Calls

A call to a function can appear where an expression may appear. Look at the examples below:

Example 1: In an element

```
<name>{uppercase($booktitle)}</name>
```

Example 2: In the predicate of a path expression

```
doc("books.xml")/bookstore/book[substring(title,1,5)='Harry']
```

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Example 3: In a let clause

```
let $name := (substring($booktitle,1,4))
```

XQuery User-Defined Functions

If you cannot find the XQuery function you need, you can write your own.

User-defined functions can be defined in the query or in a separate library.

Syntax

```
declare function prefix:function_name($parameter AS datatype)
  AS returnDatatype
{
  (: ...function code here... :)
};
```

Notes on user-defined functions:

- Use the declare function keyword
- The name of the function must be prefixed
- The data type of the parameters are mostly the same as the data types defined in XML Schema
- The body of the function must be surrounded by curly braces

Example of a User-defined Function Declared in the Query

```
declare function local:minPrice(
  $price as xs:decimal?,
  $discount as xs:decimal?)
  AS xs:decimal?
{
  let $disc := ($price * $discount) div 100
  return ($price - $disc)
};

(: Below is an example of how to call the function above :)

<minPrice>{local:minPrice($book/price, $book/discount)}</minPrice>
```

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