VICTORIA UNIVERSITY OF WELLINGTON
Te Whare Wananga o te Upoko o te Ika a Maui

An Introduction to XPath Language

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COMP 442
Issues in Databases and
Information Systems

Plan For XPath Language

- What is XPath?
- What is XPath used for
- Basic XPath syntax
- Abbreviated syntax

  - *Redings:*
    - *XML Path Language (XPath) Version 1.0*
      http://www.w3.org/TR/1999/REC-xpath-19991116

What is XPath

- XPath is a language for specifying navigation within an XML document
- It also provides basic facilities for manipulating strings, numbers, and booleans
- XPath gets its name from its use of path notation as in URLs for navigating through the hierarchical structure of an XML document
- XPath models an XML document as a tree of nodes
- Most common nodes are: elements, attributes, text
- XPath defines a way to compute a string value for each type of node

What is XPath used for

- XPath is used to define paths in an XML document in:
  - XSL Transformations (XSLT),
  - XPointer,
  - XQuery Language,
  - Within XML Schema for specifying special constraints like: key, referential integrity, and unique
- A restricted subset of XPath is used in XQuery and for specifying context of XML Schema constraints
- We are almost exclusively interested in using XPath within XQuery and for declaring constraints

XPath Location Paths

- Navigation through an XML document is declared using XPath expressions
- Although Location Paths are not the most general grammatical construct in the language, they are most important construct and we shall pay our exclusive attention to them
- Location paths can be expressed using either an unabbreviated or an abbreviated syntax
- There are two kinds of location paths:
  - Relative location paths and
  - Absolute location paths

Unabbreviated Syntax of Location Paths

- A relative location path has the following syntax:

  Path ::= $Step_1/Step_2/\ldots/Step_n$

  where each *Step* is a triple (*Axis*, *Node-test*, *Predicate*) and is defined as follows:

  Step ::= Axis:: Node-test Predicate*

  - The axis specifies the direction to move in the document tree
  - The node test selects nodes along the specified axis, and
  - The predicates (if any) filter the nodes selected
- Separators “/” between two subsequent steps indicate a direct parent-child relationship between nodes involved in the steps

Evaluation of a Relative Location Path

- A relative location path is evaluated step by step, from left to right
- A step is applied to a single node, so called *context* node
- The application of a step on a context node selects a set of result nodes
- Each node of a result set is then used as a context node in the following step
- The result of an expression is the union of node-sets selected by the last step
- Suppose a location path is declared (in an XML schema) within an element E_c declaration, then the $Step_1$ will be applied on the node-set of the type E_c (each node of the type E_c will be used as the first context node)

Result of a Relative Location Path

- The result of an expression is the union of node-sets selected by the last step
- Elements of a node-set are nodes of different types:
  - Elements, Attributes, Text, Comments, Processing Instructions,…
- According to the Standard:
  - A string value of a node is the concatenation of the string values of all text descendants of the node
- We shall obey to that definition for all node types except for complex element nodes, where we shall use the node identifier instead

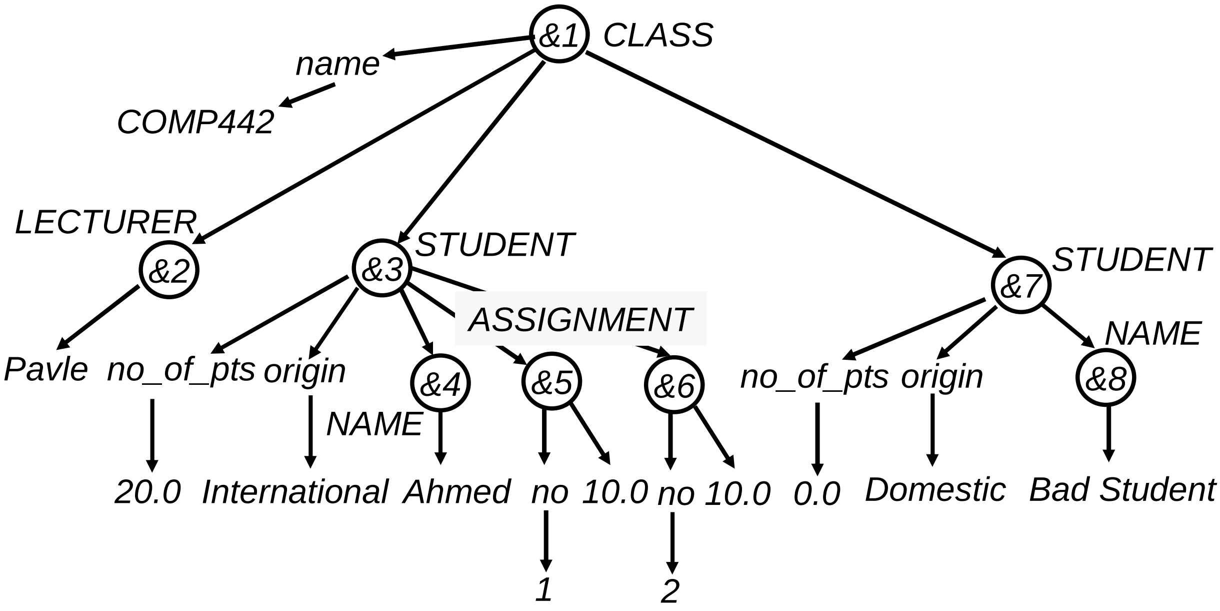
Absolute Location Path

- An absolute location path consists of a / optionally followed by a relative location path
- A leading “/” itself selects the root node of the document as the context node
- Formally:
  - LocationPath ::= RelativeLocationPath | AbsoluteLocationPath
  - AbsoluteLocationPath ::= ‘/’RelativeLocationPath
  - RelativeLocationPath ::= Step | RelativeLocationPath’/’Step
- Both relative and absolute location path may be expressed either using an unabbreviated or abbreviated syntax

A Class XML Document

```
<?xml version=“1.0” standalone=“yes”?>
<CLASS name=“COMP442”>
        <LECTURER>Pavle</LECTURER>
        <STUDENT no_of_pts=“20.0” origin=“International”>
                <NAME>Ahmed</NAME>
                <ASSIGNMENT no=“1”>10.0</ASSIGNMENT>
                <ASSIGNMENT no=“2”>10.0</ASSIGNMENT>
        </STUDENT>
        <STUDENT no_of_pts=“0.0” origin=“Domestic”>
                <NAME>Bad Student</NAME>
        </STUDENT>
   </CLASS>
```

A Class Document Tree



Axis of an XPath Step

- Within an XPath step, Axis specifies “direction” in which to navigate through a document
  - For example, the step:

    `child::STUDENT`

    where Axis = `child::` and Node-test = `STUDENT` would select all child nodes (of a context node) that have the name `STUDENT`
- The XPath supports 12 different axes for navigation
- The `child::` axis is most commonly used
- Some of the others are:
  - `attribute::` (selects attributes of a context node),
  - `descendant::` (selects descendant nodes of a context node),
  - `descendant-or-self::`
  - `parent::` (selects the parent node of a context node),
  - `self::` (selects the context node itself),

The Node-test of an XPath Step

- A Node-test specifies a simple test on XML nodes found along the steps’ axis
- The nodes that pass that test are candidates for the next step
- The most commonly used Node-test is element name
  - In the step `child::STUDENT`, `STUDENT` is an element name
- Other often used node tests are ‘*’, which evaluates to true for all element nodes, and attribute test
  - A step `child::*` will choose all subelements of a context node
  - A step `attribute:: name` will select the `name` attribute of a context node
- There are also Node-tests for:
  - Namespaces,
  - Text nodes,
  - Comments, and
  - Processing instructions

Predicates of a Step

- An XPath step can also include a sequence of predicates
- The predicates are applied to the nodes selected by Node-test
- Only nodes that evaluate to true for all predicates will belong to the result nodeset of the step
- A predicate compares a node property with a value using operators from the set {=, ≤, ≥,<, >, !=,}
- A node property can be:
  - The value of an attribute,
  - The value of PCDATA of an element, or
  - The sibling order value of a node (returned by the function `position()`)

Examples of XPath Predicates

- `child:: STUDENT[position()=2]` selects the second `STUDENT` child element of the context node
- `child::STUDENT/attribute::[origin=“International”][no_of_pts>”35”]` selects all student children of the context node that are international and have more than 35 points
- `child::STUDENT/child::NAME=“Ahmed”` selects the `STUDENT` children of the context node that have a `NAME` child with a string value equal to `Ahmed`

Abbreviated Syntax of Location Path (1)

- The most important abbreviation is that `child::` axis can be omitted from a location step
- In effect, `child::` is the default axis
- For example,
  - `STUDENT/NAME` is a short for
  - `child:: STUDENT/child::NAME`
- There is also an abbreviation for attributes: `attribute::` can be abbreviated to `@`
- For example,
  - `STUDENT[@origin=“Domestic”]` is short for
  - `child::STUDENT[attribute:: origin=“Domestic”]` and will select all `STUDENT` children of the context node whose origin is `Domestic`

Abbreviated Syntax of Location Path (2)

- If a predicate expression evaluates to an integer value that value is considered to be the position of the node selected
  - For example, `STUDENT[2]` step would select the second `STUDENT` child of the context node
- An empty step '`//`'is also a frequently used abbreviation, it specifies that the element that follows may be nested anywhere within the document
- For example,
  - `//STUDENT` would select all student nodes anywhere within the document

Abbreviated Syntax of Location Path (3)

- A location step of `.` is short for `self::node()`, where `self::` refers to the context node and `node()` returns nodes of any type
- For example,
  - `.//STUDENT` is short for
  - `self::node()/descendant-or-self::node()/child::STUDENT`

    and will select all `STUDENT` elements that are children of the context node itself or any of its descendants
- A location step of `..` is short for `parent::node()`
- For example,
  - `../LECTURER` is short for
  - `parent::node()/child::LECTURER` and will select all `LECTURER` children of the parent of the context node

Declaring Location Path in XML Schema

- A location path is declared in an XML schema using the attribute `path` within the definition of an element
- Let a location path *p* be declared within an element *E*, then the element *E* is the context of the path *p*
- The selection of the context element has to provide for an unambiguous path evaluation
- Next we are going to consider a couple of example location path declarations using abbreviated syntax

Location Path Examples (1)

- Example 1:

```
<xsd:element name="CLASS" …>
…
   <… …xpath="STUDENT/NAME"…>
…
</xsd:element>
```

  - Result = {Ahmed, Bad Student}

- Example 2

```
<xsd:element name="CLASS" …>
…
   <……xpath="STUDENT/ASSIGNMENT[@no="1"]"…>
…
</xsd:element>
```

  - Result = {10}

Location Path Examples (2)

- Example 3:

```
<xsd:element name=“STUDENT” …>
…
  <……xpath=“//LECTURER”…>
…
</xsd:element>
```

  – Result = {Pavle}

- Example 4

```
<xsd:element name=“CLASS” …>
    …
    <……xpath=“STUDENT[ASSIGNMENT=“10”] [@no=“2”]/NAME”…>
    …
</xsd:element>
```

  – Result = {Ahmed}

Location Path Examples (3)

- Example 5:

```
<xsd:element name=“STUDENT” …>
…
  <……xpath=“..”…>
…
</xsd:element>
```

  – Result = {&1}

- Example 6

```
<xsd:element name=“CLASS” …>
…
<……xpath=“STUDENT”…>
…
</xsd:element>
```

  – Result = {&3, &7}

Summary (1)

- XPath is a language for specifying navigation within an XML document
- XPath models an XML document as a tree of nodes
- A restricted subset of XPath called LocationPath is used in XQuery and for specifying context of XML Schema constraints
- A location path has the following syntax:

  $$Path ::= Step_1/Step_2/\ldots/Step_n$$

  where each *Step* is a triple (*Axis*, *Node-test*, *Predicate*):
  - The axis specifies the direction to move in the document tree
  - The node test selects nodes along the specified axis, and
  - The predicates (if any) filter the nodes selected
- An abbreviated syntax is used to declare navigation through an XML document in XQuery and when defining XML constraints

Summary (2)

- A location path can be either:
  - Relative, or
  - Absolute
- A relative location path is declared with regard to a context node and its evaluation stars from this node
- A relative location path is declared in an XML schema using the attribute `path` within the declaration of an element
- This element is the context of the relative location path declared by `path`