XML, XPath, and XSLT

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Topics

- XML is an acronym for eXtensible Markup Language.
  - Its purpose is to describe structured data
- XPath is a language for navigating through an XML document.
  - It's used to select specific pieces of information from the document
- XSLT is a language for transforming XML into something else.
  - Often used to generate HTML or another XML document.

Introduction to XML

- XML is a tagged markup language designed to describe data: LectureNote.xml
- XML has only a couple of predefined tags
  - All the rest are defined by the document designer.
  - XML can be used to create languages
- XML is commonly used to:
  - Define data structures.
  - Define messages
  - Create web pages

Validation

- To be valid XML a set of markup needs only to be well formed, see Well-Formed XML.
- To determine if an XML document belongs to some document type, XML uses either:
  - Document Type Definition (DTD)
  - XML Schema
- DTDs and Schemas define allowable tags, attributes, and value types, and may also specify where these may occur in the document structure.
  - XML schemas are written in XML, DTDs are not.

XML Element

- Elements are building blocks for XML documents
- Element sytax:
  - Elements are composed of tags, attributes, and a body:

    ```
    <tag *[attribName=“value”]>body</tag>
    ```

    example:

    ```
    <book author=“Prosise”>Programming .Net</book>
    ```

  - All parts of the element are text
  - body may contain both text and markup, e.g. lower level elements.
  - Tags and attributes are case sensitive and user defined.

Element Naming Rules

- XML names are composed of unicode characters
  - Tag names must begin with a letter or underscore
  - Other tag name characters may contain characters, underscores, digits, hypens, and periods
  - Names may not contain spaces nor start with the string “xml” or any case variant of “xml”.
  - Attribute names follow the same rules as tag names, and are also required to be unique within the tag in which they are embedded.

Element Body Rules

- Element bodies may contain text or markup or both.
  - By text, we mean character strings with no markup.
  - Markup is text with embedded markup characters:
    - & < > ‵ and ‶
  - Elements may also contain CDATA sections, designed to support text including large sections of markup but not interpreted as markup:
    - <! [CDATA[…]]>
    - These cannot be used to carry binary data.

Illegal Characters

- Certain characters are reserved for markup and are illegal in names and payload text:

&lt;	<	less than
&gt;	>	greater than
&amp;	&	ampersand
&apos;	‘	apostrophe
&quot;	“	quotation mark

- We represent them in XML with the escape sequence shown on the left, e.g.: &lt; if we want a less than character in payload text.

XML Structure

- An XML document is defined by a standard opening processing instruction:
  - `<?xml version=“1.0” ?>`
  - Processing instructions and comments are the only XML tags that are not closed (see next page)
- The XML body starts with a single root element.
- An element is text of the form:

  ```
  <someTag anAttribute=“someValue”>payload text</someTag>
  ```

  where the payload may be one or more child elements or simply text or both.
- Comments take the form:

  ```
  <!– a comment -->
  ```

Well-Formed XML

- XML has a few rules:
  - There may be only a single root
  - All tags, except for processing instructions, must be closed:
    - <myTag someAttrib=“value”>…</myTag>
    - <myTag someAttrib=“value”/>
  - Attribute values must be quoted
  - XML tags are case sensitive
  - All markup and payload is text with one exception:
    - An element may define a CDATA section
    - CDATA is not parsed, and so may contain anything except the CDATA terminator

CDATA

- A CDATA section has the syntax:

```
<![CDATA[ … ]]>
```

- CDATA is not parsed except to look for the terminator "]]>" so it may containing anything.
  - It is not a good idea to try to store binary data in a CDATA section because the "]]>" sequence could appear as part of the binary data.

XML Documents

- An XML document is well-formed XML if it contains:
  - A prolog: <? xml version="1.0" ?>
  - An optional link to an XSLT stylesheet
  - An optional reference to a DTD or schema, used for validation
  - Optional processing instructions
  - Optional comments
  - A body with a single root, which may contain any number of text sections, elements, and comments
  - An optional epilogue consisting of comments and processing instructions

Processing Instructions

- Processing instructions are used to capture information for XML parsers and proprietary applications.
  - Syntax: <? PI-target *[attrib=“value”]?>
- The most common processing instructions are:
  - Document banner:
    <? xml version=“1.0” encoding="utf-8" ?>
  - XSLT style-sheet reference:
    <?xml-stylesheet type="text/xsl" href="courses.xsl" ?>
- Other hypothetical instructions:
  - <? robots index="no" follow="yes“ ?>
  - <? word document=“aDoc.doc” ?>

Namespaces

- Namespaces are declared with special attributes and prefixes:
  - <tag xmlns:prefix=“uri”>body</tag>
  - The uri should be unique, so current style is to use a url, e.g., www.ecs.syr.edu.
  - These urls need not be bound to some real site.
  - Attributes do not inherit the namespace of their element, so you need to do this:
    <tag xmlns:a=“uri” a:myAttrib=“value”>body</tag>
- Namespaces are used to distinguish different elements that happen to have the same tag name, but are not intended to mean the same thing.
  - Perhaps, they have different structures

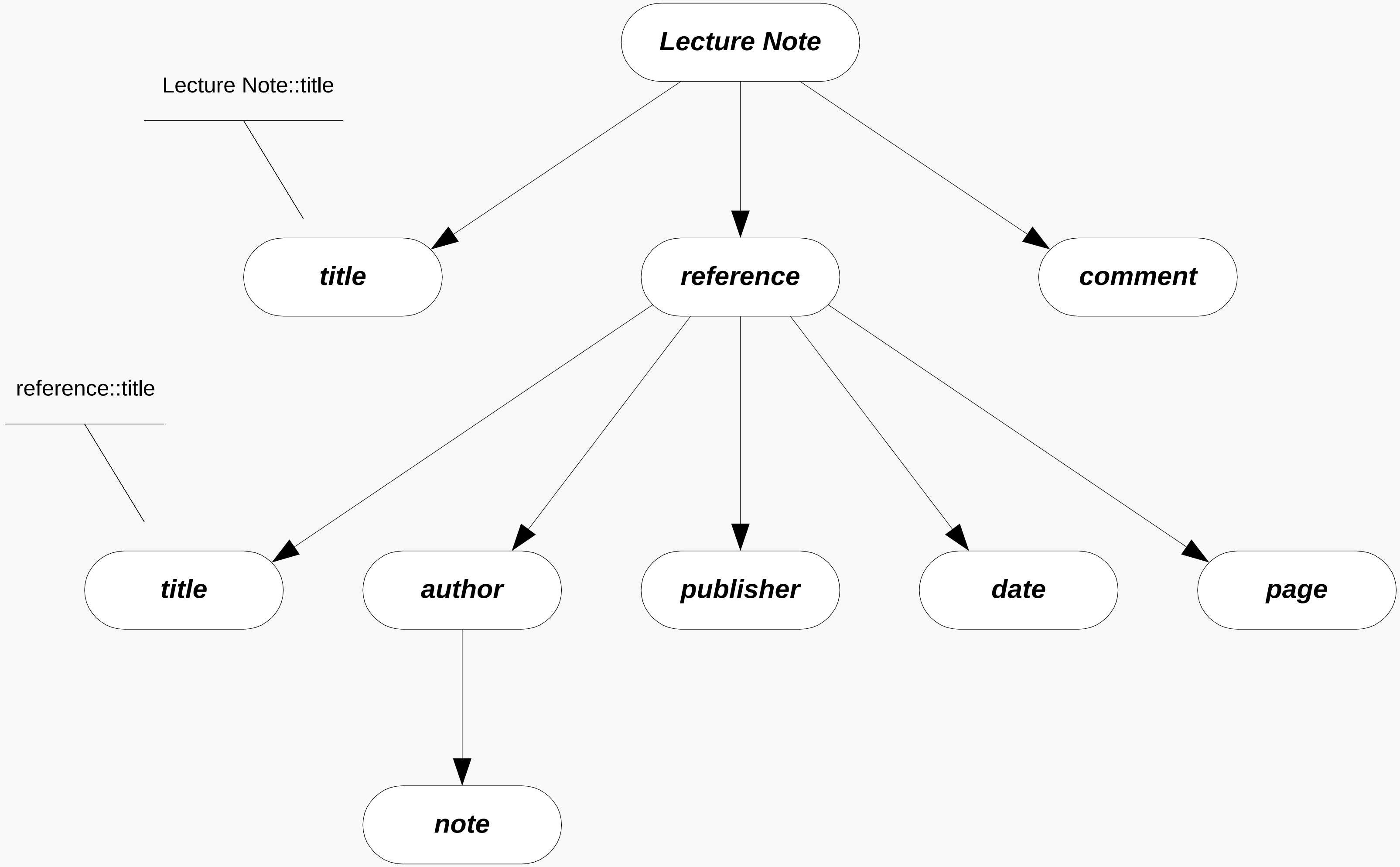
Example

```
<?xml version=“1.0” ?>
<!-- XML test case -->
  <LectureNote course=“cse681”>
    <title>XML Example #1</title>
    <reference>
      <title>Programming Microsoft .Net</title>
      <author>
        Jeff Prosise
        <note company=“Wintellect”></note>
      </author>
      <publisher>Microsoft Press</publisher>
      <date>2002</date>
      <page>608</page>
    </reference>
    <comment>Description of PCDATA</comment>
  </LectureNote>
```

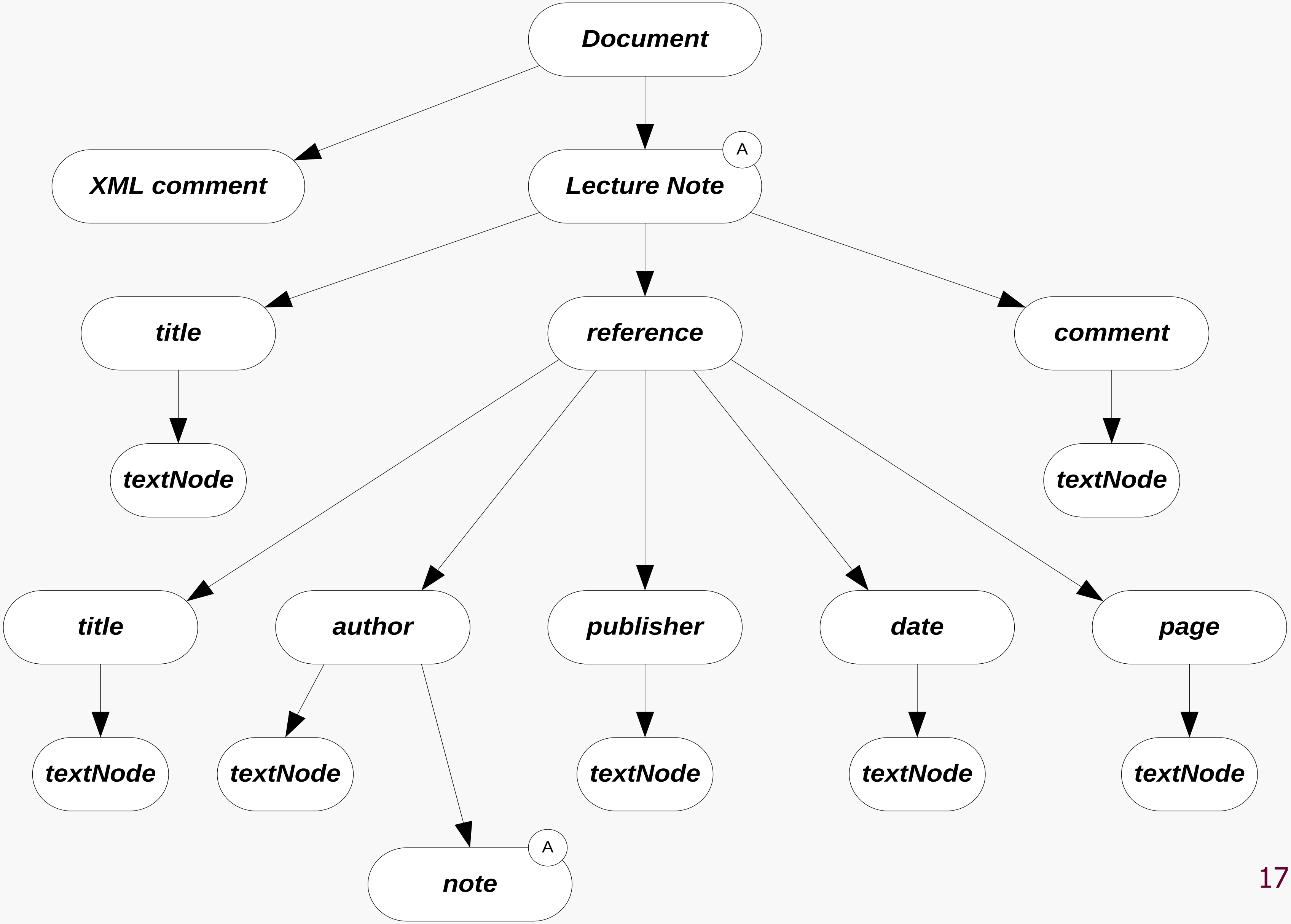
Note: we can have both text and child nodes in the payload of an element.

LectureNote.xml
Webmonkey | Reference: Special Characters

XML Node Structure



XML Parse Tree



XML Presentation

- There are several ways XML data can be presented to a user:
  - XML data island in an HTML page, interpreted by script
  - XML file interpreted by script in an HTML page
  - XML island or file bound to an HTML table
  - XML file bound to a GridView control
  - XML styled with an XSL style sheet
    - Essentially, the XSL sheet creates viewable HTML
  - Read, interpreted, and modified by an application
    - The .Net System.XML library provides very effective support for this.

XML Demonstrations

- XML Demonstration Web Pages

Introduction to XPath

- XPath provides a navigation facility within XML documents
  - XPath is used to extract specific information from XML documents:
    - In XSL style sheets
      - » <xsl:template match=xpath expression>
      - » <xsl:for-each select=xpath expression>
      - » <xsl:value-of select=xpath expression>
      - » <xsl:apply-templates select=xpath expression>
    - In C# programs that use the XML DOM
      - » XmlNode.SelectSingleNode(xpath expression)
      - » XmlNode.SelectNodes(xpath expression)
    - In Javascript code

XPath Components

- XPath syntax contains the following components:
  - Steps
    - A directory like syntax for defining elements and attributes at some specified level
      - /customers/customer/lastName
      - /customers/customer[@status = current]
  - Descent Steps
    - Steps that may occur at any level in an XML structure
      - //lastName
  - Filters
    - Elements or attributes that must be present to result in a match
    - /customers/customer[country]
  - Predicates
    - Condition that must be met to result in a match
    - /customers/customer[country="United States of America"]

XPath Node Set Functions

- XPath provides a number of functions that operate on sets of nodes:
  - count()
    - the number of nodes in a set
    - /customers/customer[count(order) = 1], e.g., customers with only one order
  - position()
    - position returns the position of an XML node in a set of nodes:
    - /customers/customer[position() = 1], e.g., first customer
  - last()
    - Returns the ordinal of the last node in a set
    - /customers/customer/order[position() = last()], e.g., last order of each customer

XPath String Functions

- XPath has three commonly used string functions:
  - contains()
    - Returns true if string in first argument contains the second
    - //customer[contains(jobTitle,”chief”)]
  - string-length()
    - Returns integer number of characters in string
    - //customer[string-length(lastName) > 3]
  - substring()
    - substring(str,start,length) returns substring of str starting at character start with number of characters equal to length
    - //customer[substring(city,0,3) = “Los”]

Other XPath Functions

- XPath number functions:
  - sum()
    - sum(products/product/price)
- Boolean functions
  - false()
  - true()
  - not()
    - //customer[not(count(orders) = 0)]

XPath Expressions

- XPath supports numerical, boolean, and comparison expressions:
  - create complex predicates
  - //customer[count(orders) > 0 and State = “California”]
- XPath unions
  - return the union of two node sets
  - //books | //articles

XPath Axes

- XPath axis specifies the direction of node selection from the context node:
  - child
    - Child nodes of the context node
  - parent
    - Parent node of the context node
  - ancestor
    - All ancestors of the context node
  - descendent
    - All decendents of the context node
  - attribute
    - Attributes of the context node

Axes Examples

- /customer/lastName
  - /child::customer/child::lastName
- //firstName
  - desendant::firstName
- //drive/@letter
  - //drive/attribute::letter
- //file/../@name
  - //file/parent::folder/@name
- //folder[parent::folder and not(child::file)]
  - Subdirectories with no files

Introduction to XSLT

- XSLT is an acronym for eXtensible Stylesheet Language – Transform.
- Designed to transform an input XML parse tree into a parse tree for the output – often XML or HTML.
- The transformations are defined as templates in a stylesheet, with extension xsl.
- .Net provides several classes to support this operation.

XSLT Template Processing

-
  ```
  <xsl:template match=XPath expression>
     // processing defined for the
     // matching node set
  </xsl:template>
  ```

- Processing consists of:
  - Literals that are sent directly to the output
  - Templates with their results sent to the output

- An XSLT stylesheet can have an arbitrary number of templates.

- Templates are processed at two points in time:
  - When the transformation is first invoked.
  - Whenever `<xsl:apply-templates />` is encountered during processing.

apply-templates

- `<xsl:apply-templates />`
- The current selection is matched against all templates in the stylesheet.
- Each match executes the matching template’s processing.
- The results are sent to the output.

for-each

- `<xsl:for-each select=XPath expression>`

  // processing for selections

  `</xsl:for-each>`

- Each element of the matching node set is processed according to the body of the template.
- Results are sent to the output.

value-of Template Instruction

- `<xsl:value-of select=XPath expression />`

- Returns the value of the selected node
- The selection is from the context defined by the template selection (see previous slide).

Example

- The links, below, refer to an example of XSLT processing, executed on a web server, to render a webpage based on contents of an XML file:
  - www.ecs.syr.edu/faculty/fawcett/handouts/cse686/code/XSLTdemo/XSLTdemo.aspx
  - www.ecs.syr.edu/faculty/fawcett/handouts/cse686/code/XSLTdemo/XSLTFile.xsl
  - www.ecs.syr.edu/faculty/fawcett/handouts/cse686/code/XSLTdemo/XMLFile_NoStyleLink.xml