A First Look at XML

Michael B. Spring
Department of Information Science and Telecommunications
University of Pittsburgh
spring@imap.pitt.edu
http://www.sis.pitt.edu/~spring

Overview

- XML Basics
- Documents and Document Type Definitions
- Related and Companion Standards for XML
  - Schemas, namespaces, and datatypes
  - XPath
  - XML Linking Language (XLL)
  - XML Style Language (XSL)
  - XSL Transformation (XSLT)

Background

- XML is both simplified and extended SGML
  - Complex features defined for SGML that no are longer needed were eliminated
  - New capabilities, particularly related to datatypes were added
- XML has an extensive set of companion standards
  - The XML companion standards are in a state of flux
- The XML tools and standards are still in transition
- Suggested Readings
  - XML Standard -- www.w3c.org/XML
  - Goldfarb and Prescod, The XML Handbook
  - Harold, The XML Bible

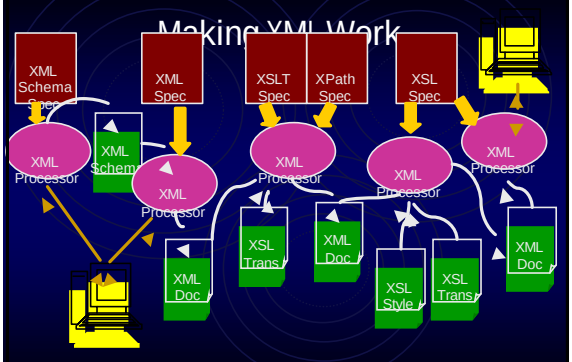
The Basic Idea

- XML, and SGML, are languages that define the rules for describing classes of documents.
  - Under SGML these definitions were called Document Type Definitions or DTDs
  - Under XML, DTDs were used initially, but have now given way to Schemas
- There are syntactic rules for writing documents generally and additional rules imposed by the DTD or Schema
  - A document that meets the syntactic rules defined for writing XML documents is said to be "well formed"
  - A document that complies with the constraints set out in a DTD or Schema is said to be valid

XML Family of Standards

- Schemas provides a number of new capabilities:
  - Document schemas allow DTDs to be defined as XML documents – requiring only a single parser.
  - Namespaces allow for modular document definition, multiple inheritance, and collision avoidance
  - Data types can be defined to allow for attribute value and content value controls
- Companion standards
  - XPath or the XML Path Language allows navigation of the document tree
  - The XPointer allows tree components as targets
  - The XML Linking Language defines linking capability
  - The XML Style Language defines presentation capability
  - XSLT provides for the transformation of documents

Making XML Work



Basic XML Syntax

- An XML document is made up of:
  - a prolog
    <?xml version="1.0" encoding="UTF-8" standalone="yes"?>
    <!DOCTYPE MYBOOK SYSTEM "mybook.dtd"> (DTD form)
  - an instance
    - a nested set of elements beginning with the root element which has the same name as the DTD (Using Schema, the root element is associated with the schema name space.
- An element begins and ends with tags
  - The start tag is of the form <NAME>
  - The end tag isof the form </NAME>
- Tag names:
  - Are case sensitive (75% of XML errors are related to case sensitivity)
  - begins with a letter or underscore and may include letters, digits,hyphens, underscores, colons and periods

Additonal XML Syntax

- The characters in an XML document are Unicode
- Whitespace is any combination of spaces, tabs, carriage returns, and line feeds, and is generally ignored
- Tags, processing instructions, comments and entity references are all considered markup
  - Entity references are of the form &NAME;
  - Comments are of the form <!-- message -->
  - A processing instruction is included using <? ?> delimiters
- In a DTD or Schema, additional forms appear, called declarations. These include:
  - Element declarations or content models
  - Attribute declarations
  - Entity definitions

"Escaping" Markup in Content

- XML has five predefined entities which may be used to allow markup symbols to be included in the content:
  - < ::= < > ::= >
  - ' ::= ' " ::= "
  - & ::= &
- CDATA sections may also be used to include data that would confuse a parser
  - <![CDATA[content]]>
  - obviously, the content cannot include]]

Developing a DTD

- A formal XML document complies with a document type definition, or a schema
- This is accomplished by the DOCTYPE element, which may be defined locally:

```
<!DOCTYPE note [
<!ELEMENT note (to, from, date, message)>
<!ELEMENT to (#PCDATA)>
<!ELEMENT from (#PCDATA)>
<!ELEMENT date (#PCDATA)>
<!ELEMENT message (#PCDATA)> ]>
```

- The DOCTYPE may also be referenced:

```
<!DOCTYPE note SYSTEM "note.dtd">
```

- The two methods may be combines

```
<!DOCTYPE note SYSTEM "note.dtd" [
<!ENTITY DOLLAR "$"> ]>
```


The Content Model of and Element

- The content of an element may be
  - a set of subelements
  - text
  - a set of subelements and text
  - An empty element
  - an element with "ANY" content
    - normally used only for development
- Elements in a content model may be
  - Required (default if no modifier)
  - Optional (?)
  - Repeatable (*, +)
- Elements in a content model may be
  - ordered (,)
  - ored (|)
  - (Schemas only) – an unordered set

Attributes

- An attribute definition defines the attributes of an element. It takes the general form
  - <!ATTLIST element name value/range default>

```
<!ATTLIST memo status ("draft"| "final") "final">
```

- The element memo would appear as follows:

```
<memo status = "draft">
```

- The value range must either be a group or a reserved word.
- The default must be either a reserved name or a user supplied value. Default values may include the following:
  - #REQUIRED -- must be supplied
  - #IMPLIED -- optional (will be supplied by the system if absent)
  - #CURRENT -- is the most recent value

Reserved Words for Values

- The reserved words can be:
  - CDATA -- character data
  - NUMBER (NUMBERS) -- a number or numbers
  - NAME (NAMES) -- one or multiple name strings
  - NMTOKENS -- names that can begin with a number
  - NUTOKENS -- names that must begin with a number
  - ID – a valid SGML name unique within the scope of a document
  - IDREF -- must match an ID in the document.

Entities

- Entities may be of any number of forms – consistent with SGML
- The keywords INCLUDE and IGNORE may be used to allow conditional sections
  - <![INCLUDE [stuff to include]]>
  - <![IGNORE [stuff to ignore]]>
- an entity may be defined that makes this more flexible
  - <!ENTITY % notes "IGNORE">
  - <![%notes; [stuff to include]]>
- Character references use the form &#ddd; where ddd are decimal digits that specify the unicode character
  - to reference the hex number use ෝ

Processing Instructions

- A processing instruction begins with <? and ends with ?>
  - the <? is followed by a target processor name
  - after the target processor name is any processing instructions followed by ?>
- The xml processing instruction for stylesheets looks as follows

```
<?xml:stylesheet href="url" type="text/xsl"?>
```

XML Companion Standards

- Schemas provide new capabilities beyond DTDs
  - Namespaces provide a mechanism for multiple inheritance
  - The content model (aka DTD) is a normal XML document
  - Datatypes allow more formal typing of data
- XPath or XML Path Language describes documents
- The XML Pointer Language allows paths as anchors
- The XML Linking Language provides extended linking capability
- XSL -- the XML Style Language provides presentation control
- XSLT provides for the transformation of documents

Schemas

- XML Schemas replace DTDs
  - Schemas are recursively defined – i.e., a Schema is an XML document that is defined by a Schema that is an XML document …
  - Schemas recognize and allow for datatypes both for attribute values and element content
  - Schemas recognize "namespaces", a relaxation of the one DTD/document constraint
  - Schemas allow additional new features to be defined at a later date
- The Schema debate has been clouded by the simultaneous development of datatypes (Schema part 2) and RDF – Schema of a different color

Namespaces

- Namespaces provide
  - namespaces are being widely used, but they are controversial
  - a way to expand the scope of XML elements
  - a mechanism for multiple inheritance
- Namespaces allow two different elements with the same name
  - the basic idea is to provide a qualifier for the element
    - thus sis.pitt.edu:para could be distinguished from gsia.cmu.edu:para
  - domain names could work but it would require a registered name for a namespace

Namespace rules

- The attribute xmlns defines the default namespace for an element

  <html xmlns="http://www.w3.org/TR/WD-HTML40">
  - The attribute name xmlns is reserved
  - This attribute defines the default namespace
  - The subelements of this element are defined within the namespace
  - A subelement with a different default namespace attribute is allowed – all subelements must be defined within that namespace
  - attribute names are also defined in the namesapce
  - The advantage of this form of namespace declaration is that it allows element names to be used without a prefix

Qualified Namespaces

- An attribute name composed of xmlns: followed by a name is called a qualified namespace

  <mbs:email xmlns:mbs="http://….">
  - The namespace is called called mbs
  - Subelements of this namespace must be prefaced by mbs:
- This allows multiple namespaces to be used simultaneously. Thus:

  <html:html xmlns:spring="href1" xmlns:html="href2" xmlns:math="href3">
  - allows the children of html to be:

    <html:xxx>
    <math:yyy>
    <spring:vv>

Datatypes Under DTDs

- SGML, and XML under DTDs, put content outside the scope of the standard.
  - Element content was only checked related to syntax – i.e. PCDATA, CDATA, NDATA.
  - Attribute values allowed some "datatypes" checking, but it was minimal as well
    - ID IDREF
    - NMTOKEN NOTATION
- For e-commerce applications, XML required stronger data type capabilities

Schema Datatypes

- The datatype work under schemas adds more primitive types, which can be applied not only to attribute values but to element content
  - string Boolean
  - number DateTime
  - binary uri
- Additional system datatypes , called generated are defined based on the primitive types.
  - integer decimal
  - real date
  - time timePeriod

Defining and Using a datatype

- The user may also define datatypes . For example:

```
<xsd:simpleType name="pubyear">
  <xsd:restriction base="xsd:gYear">
    <xsd:minInclusive value="1000"/>
    <xsd:maxInclusive value="3000"/>
  </xsd:restriction>
</xsd:simpleType>
```

- An attribute declaration could now be defines:

```
<attribute name = "Date"  type = "pubyear"/>
```

- An element declaration could be deifned:

```
<xsd:element name= "publishdate" type = "pubyear"/>
```


XPath

- XPath is a kind of SQL for XML
- XPath views a document as a tree of nodes
- The XML Path language identifies parts of an the XML document tree
  - XPath is used by XPointer to build a web address
  - XPath is used by XSLT to transform a document
- The topmost part of the tree is the root
  - it is not the same as the root element
  - a node contains all the comments, elements, text, attributes and PI

Examples of XPaths

- An XPath identifies a set of nodes in a document tree:
  - /mydoc/chap/section
    - would select the section elements of the chap elements in mydoc
  - /mydoc/chap/para[7]
    - would get the seventh para elements of all chap elements
  - /mydoc/chap[@stat="draft"]
    - would select all chaps whose stat attribute has a value of "draft"

XPath Expression

- An instance of an XPath is called an expression
  - Applications processes the expression returning a node set which the application then processes
  - An expression can be absolute or relative
  - An expression can traverse the tree in a number of different directions – called axes
  - An expression can include a variety of tests in the form of functions and predicates

Axes and Tests

- Axes specify how the tree is traversed
  - There are actually 13 different axes. For example:
    - The child axis, the default, looks down the tree one step
    - The parent axis looks up the tree one step
    - The attribute axis allows the attributes of a node to be explored
- Functions and predicates can be used to filter nodes
  - text() and comment() are examples of functions that would allow only one kind of node
  - para[7], para[last()], para[footnote] are examples of predciates that select the seventh, last, and paragraphs with footnotes respectively

HTML Anchors

- HTML linking is currently based on URL, URI, and URN's
- it is important to know what is what
  - URL's and URN's are URI
  - URI is an abstract concept
  - URN's will probably manifest themselves in new forms
  - what we commonly put in an href is a URL
  - a fragment identifier is an addition to the URL
  - it is based on fixed semantics – <A NAME="lit">
- XML linking is much more robust than HTML linking
- XML linking will require/allow radically new kinds of applications

Paths and Pointers

- Path information allows a link to be made to a specific location within a document using Xpointer
- Xpointer extends the capabilities of URI, URL, URN, and fragment identifier
- In some ways, Xpointer is a shell for Xpath
  - consider the following url:
    - http://www/c/g/xyz.xml#xptr(/mydoc/chap[3])

XLINK

- xlink is an example of one namespace
  - <mbslink xmlns:xlink=http://www.w3.org/XML/Xlink/0.9 xlink:type = "simple">
  - XML does not know about namespaces, therefore care has to be taken in using them
  - the namespace abbreviations must be hardcoded in the dtd

The XML Linking Language (XLL)

- XLL provides more linking capability
- simple linking, like that in html would look as follows
  - <citation xlink:type="simple“
  - xlink:href=URL>text</citation>
- use of the xlink attributes requires the xlink namespace
  - <rootname xmlns:xlink="http://www.w3.org/XML/Xlink/0.9">

XLINK Attributes

- the definition of Xlink allows a variety of different link types to be developed.
- many of these are defined by the show attribute of xlink; xlink:show may be set to the following values
  - "replace" does what we see on the WWW
  - "new" causes a new window to be opened
  - "parsed" causes the href to be parsed and included
- another attribute of xlink is actuate which can take the following values
  - "user" indicates that traversal is based on user action
  - "auto" specifies that traversal should be automatic

Extended Links

- extended links include links that make use of the locator element
  - <mylink xlink:type="extended">
    - <locator xlink:type="locator“ xlink:href = "url“
    - xlink:role="type of link">
    - <locator xlink:type="locator“ xlink:href = "url“
    - xlink:role="type of link">
  - </mylink>
- link groups allow sets of documents to be linked together
- behavior and processing of these is undefined
  - <xlink:group>
    - <xlink:document href="url"/>
    - <xlink:document href="url"/>
    - <xlink:document href="url"/>
  - </xlink:group>

The XML Style Language

- XSL provides more presentation capability
- XSL is a rendition language
  - it provides an alternative to the CSS as a style sheet
  - it makes use of the xmlns:xsl and xmlns:fo
    - fo stands for formatting object
    - this looks very similar to the layout hierarchy specified for interpress and ODA
    - the layout root is fo:root
      - the root has one or more fo:page-sequences
      - within the page sequences are flow elements fo:flow

Flow Elements

- the fo:flow elements contain other blocks
- fo:block
- fo:inline-graphic
- fo:display-graphic
- fo:display-rule (a ruling line)
- fo:display-sequence a set of attributes for a set of blocks
- fo:table
- fo:list-block
- fo:list-item-body
- fo:list-item-label and fo:list-item
- fo:simple-link
- fo:page-number

XSLT

- XSLT provides for the transformation of documents
- We can select, match, choose, filter, get the value of, etc.
- XSLT has two main functions
  - an intermediate language for making html documents from XML
  - an ultimate processor for taking XML documents to multiple forms

XSLT Processors

- Keep in mind that the XSL processor in ie5 is not fully conforming
- XSLT makes use of XSL style sheets
  - formally, the style sheet would begin:
    - <xsl:stylesheet xmlns:xsl=http://www.w3.org/Transform/1.0
    - xmlns:html=http://www.w3.org/TR/REC-html40
    - result-ns="html">
    - …. rules…
    - </xsl:stylesheet>
  - for ie 5 use
    - <xsl:stylesheet version="1.0"
    - xmlns:xsl="http://www.w3.org/TR/WD-xsl">
  - The rules are template rules

Style Sheets and Templates

- A style sheet is made up of a set of templates
- The template contain instructions on how to process the element they match

```
<xsl:template match="book">
    ... information on how to format book
</xsl:template>
```

- A template does three things:
  - It outputs the literal content of the template element
  - It selects content from the input document and outputs it
    <xsl:value-of select="relative Xpath"/>
  - It applies additional templates
    <xsl:apply-templates select="relative Xpath"/>
- Apply-templates provides for recursive handling of the templates

An Example

- There are a whole series of structures and tests available as well. For example:

```
<xsl:if select="relative Xpath">
do something
</xsl:if>
```

- Within a template, the order of subelements can be changed, in this case processing the paragraphs of a section before the title.

```
<xsl:template match="section">
<xsl:apply-templates select="para"/>
<xsl:value -of select="title"/>
</xsl:template>
```

XML Tools

- There are lots of different XML tools out there.
- Two new commercial offerings that now incorporate schema and datatypes are:
  - XMLSpy
  - TurboXML
- To play with validation and wellformedness as well as XSLT
  - IE5
  - xt by James Clark
- To code XML programmatically:
  - jaxp
  - xerces and xlan

XML Spy

Turbo XML