04. Fundamentals of XML

IT2406 – Web Application Development I

Level 1 - Semester 2

XML Overview

What is XML?

- ❑ Standard “markup” language for information
  - SGML with 80% functionality but 20% complexity
  - Designed by W3C member companies
- ❑ Extensible
  - Can be used for both documents and messages
  - Unlike HTML, new “tags” can be defined
- ❑ International
  - Based on Unicode character set

HTML But Better…

- ❑ HTML
  - Defines “visual” document layout
    - Paragraphs, images, etc…
  - Browsers allow liberal use (and abuse)
- ❑ XML
  - Defines semantic structure for data
    - Music collection, financial transaction, etc…
  - Strict definition for document syntax

The Basic Rules

- XML is case sensitive
- All start tags must have end tags
- Elements must be properly nested
- XML declaration is the first statement
- Every document must contain a root element
- Attribute values must have quotation marks
- Certain characters are reserved for parsing

Common Errors for Element Naming

- Do not use white space when creating names for elements
- Element names cannot begin with a digit, although names can contain digits
- Only certain punctuation allowed – periods, colons, and hyphens

Walking through an Example

- ❑ Modify the computer.xml document
  - Add a new element named “software” with an attribute named “language”
  - The attribute’s value should be the name of a programming language
  - Create another XML element called “IFStatment”
  - Use the IFStatment element to tag the following data: if (a < b && b >= 0)
  - Close the “software” tag
- ❑ After you have added these new items into the XML document, parse it again to ensure that it is still well formed. Use the feedback to correct any errors.

Part 2: Legal Building Blocks of XML

- A Document Type Definition (**DTD**) allows the developer to create a set of rules to specify legal content and place restrictions on an XML file
- If the XML document does not follow the rules contained within the DTD, a parser generates an error
- An XML document that conforms to the rules within a DTD is said to be **valid**

Why Use a DTD?

- A single DTD ensures a common format for each XML document that references it
- An application can use a standard DTD to verify that data that it receives from the outside world is valid
- A description of legal, valid data further contributes to the interoperability and efficiency of using XML

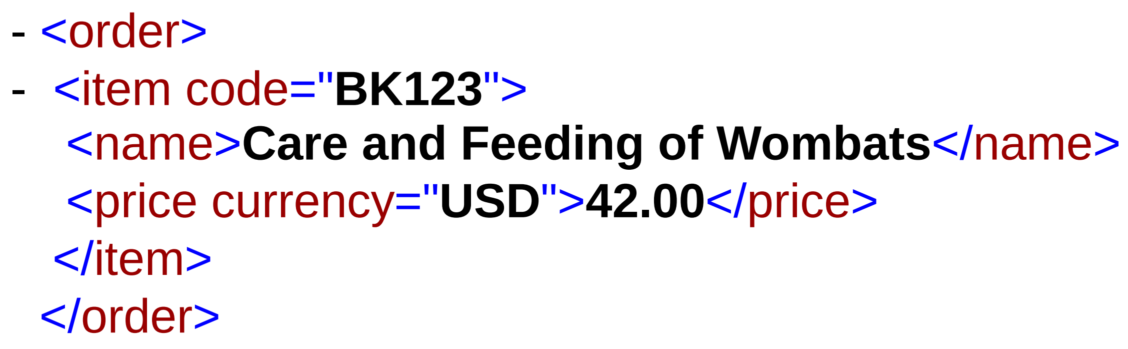
An Example in HTML

```
<table border=‘1’>
  <tr style=‘background:black;color:white’>
    <th>Item
    <th>Price
  </tr>
  <tr valign=‘top’ style=‘background:silver’>
    <td>BK123 - <u>Care and Feeding of Wombats</u>
    <td>$42.00
  </tr>
</table>
```

Item	Price
BK123 - Care and Feeding of Wombats	$42.00

The Same Thing in XML

```
<order>
  <item code='BK123'>
    <name>Care and Feeding of Wombats</name>
    <price currency='USD'>42.00</price>
  </item>
</order>
```



```
- <order>
-  <item code="BK123">
     <name>Care and Feeding of Wombats</name>
     <price currency="USD">42.00</price>
   </item>
  </order>
```

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The Business Connection

- ❑ Protocol independence
  - Eases intra-business communication
  - Allows information interchange with partners
- ❑ Platform independence
  - Bridges legacy systems to new applications
- ❑ Open standard
  - Freedom from data control (e.g. EDI)
  - Everyone “speaks” the same language

XML Syntax: Documents

Basic Document Structure

- ❑ Element tags
  - Elements have associated attributes
- ❑ Text content
- ❑ Miscellaneous
  - Encoding, document type declarations
  - Entity references
  - Comments, processing instructions, etc…

Example XML Document (1 of 6)

- XML declaration

```
<?xml version=‘1.0’ encoding=‘Shift_JIS’?>
<!DOCTYPE order SYSTEM ‘grammar.dtd’>
<?xml-stylesheet type=‘text/xsl’ href=‘style.xsl’?>
<order>
  <item code=‘BK123’>
    <name>Care and Feeding of Wombats</name>
    <price currency=‘USD’>42.00</price>
  </item>
</order>
```

Example XML Document (2 of 6)

- Document type declaration

```
<?xml version=‘1.0’ encoding=‘Shift_JIS’?>
<!DOCTYPE order SYSTEM ‘grammar.dtd’>
<?xml-stylesheet type=‘text/xsl’ href=‘style.xsl’?>
<order>
  <item code=‘BK123’>
    <name>Care and Feeding of Wombats</name>
    <price currency=‘USD’>42.00</price>
  </item>
</order>
```

Example XML Document (3 of 6)

- Processing instructions

```
<?xml version=‘1.0’ encoding=‘Shift_JIS’?>
<!DOCTYPE order SYSTEM ‘grammar.dtd’>
<?xml-stylesheet type=‘text/xsl’ href=‘style.xsl’?>
<order>
  <item code=‘BK123’>
    <name>Care and Feeding of Wombats</name>
    <price currency=‘USD’>42.00</price>
  </item>
</order>
```

Example XML Document (4 of 6)

- Element tags

```
<?xml version=‘1.0’ encoding=‘Shift_JIS’?>
<!DOCTYPE order SYSTEM ‘grammar.dtd’>
<?xml-stylesheet type=‘text/xsl’ href=‘style.xsl’?>
<order>
  <item code=‘BK123’>
    <name>Care and Feeding of Wombats</name>
    <price currency=‘USD’>42.00</price>
  </item>
</order>
```

Example XML Document (5 of 6)

- Attributes of element tags

```
<?xml version='1.0' encoding='Shift_JIS'?>
<!DOCTYPE order SYSTEM 'grammar.dtd'>
<?xml-stylesheet type='text/xsl' href='style.xsl'?>
<order>
  <item code='BK123'>
    <name>Care and Feeding of Wombats</name>
    <price currency='USD'>42.00</price>
  </item>
</order>
```

Example XML Document (6 of 6)

- Text content

```
<?xml version=‘1.0’ encoding=‘Shift_JIS’?>
<!DOCTYPE order SYSTEM ‘grammar.dtd’>
<?xml-stylesheet type=‘text/xsl’ href=‘style.xsl’?>
<order>
  <item code=‘BK123’>
    <name>Care and Feeding of Wombats</name>
    <price currency=‘USD’>42.00</price>
  </item>
</order>
```

Differences with HTML

- ❑ Elements must be balanced, properly nested
  - e.g. <br />   OK
  - e.g. <b>bold <i> and italic </i> text</b>   OK
  - e.g. <b>bold <i> and italic </b> text</i>   BAD!
  - e.g. <ul> <li> list item </ul>   BAD!
- ❑ Attributes must be specified, quoted
  - e.g. <img src=‘images/banner.gif’/>   OK
  - e.g. <img src=images/banner.gif />   BAD!
  - e.g. <ul compact> <li> list item </li> </ul> BAD!

Other Important Points

- ❑ Documents *must* be well-formed
  - Document contains single root element
  - Elements are balanced and properly nested
  - Attributes are specified and quoted
  - Text content contains legal XML characters
- ❑ Documents *may* be valid
  - Document structure and content follows rules specified by grammar (e.g. DTD, XML Schema)

XML Syntax: DTDs

Validation of XML Documents

- ❑ XML documents *must* be well-formed
- ❑ XML documents *may* be valid
  - Validation verifies that the structure and content of the document follows rules specified by grammar
- ❑ Types of grammars
  - Document Type Definition (DTD)
  - XML Schema (XSD)
  - Relax NG (RNG)

What is a DTD?

- ❑ Document Type Definition
  - Defined in the XML 1.0 specification
  - Allows user to create new document grammars
    - A subset borrowed from SGML
    - Uses non-XML syntax!
  - Document-centric
    - Focus on document structure
    - Lack of “normal” datatypes (e.g. int, float)

Document Structure

- ❑ Element declaration
  - Element name
  - Content model
- ❑ Attribute list declaration
  - Element name
  - Attribute name
  - Value type
  - Default value

Element Declaration

❑ Content models

- ANY
- EMPTY
- Children
  - Nestable groups of sequences and/or choices
  - Occurrences for individual elements and groups
- Mixed content
  - Intermixed elements and parsed character data

Children Content Model

- ❑ Sequences
  - Order required e.g. (foo,bar,baz)
- ❑ Choices
  - Any one from list e.g. (foo|bar|baz)
- ❑ Nested sequences and choices
  - e.g. (foo,bar,(baz|mumble))
  - e.g. (foo|(bar,baz))

Children Occurrences

- ❑ Specify occurrence count for…
  - Individual elements
  - Groups of sequences and choices
- ❑ Occurrences

• Exactly one	e.g.	foo	(foo,bar)
• Zero or one	e.g.	foo?	(foo,bar)?
• Zero or more	e.g.	foo*	(foo|bar)*
• One or more	e.g.	foo+	(foo|bar)+

Attribute List Declaration

- ❑ Value types
  - CDATA
  - ENTITY, ENTITIES
  - ID, IDREF, IDREFS
  - NMTOKEN, NMTOKENS
  - NOTATION
  - Enumeration of values   e.g. (true|false)
- ❑ Default value
  - #IMPLIED, #REQUIRED, #FIXED
  - Default value if not specified in document

Example DTD (1 of 6)

- ❑ Text declaration

```
<?xml version='1.0' encoding='ISO-8859-1'?>
<!ELEMENT order (item)+>
<!ELEMENT item (name,price)>
<!ATTLIST item code NMTOKEN #REQUIRED>
<!ELEMENT name (#PCDATA)>
<!ELEMENT price (#PCDATA)>
<!ATTLIST price currency NMTOKEN 'USD'>
```

Example DTD (2 of 6)

- Element declarations

```
<?xml version=‘1.0’ encoding=‘ISO-8859-1’?>
<!ELEMENT order (item)+>
<!ELEMENT item (name,price)>
<!ATTLIST item code NMTOKEN #REQUIRED>
<!ELEMENT name (#PCDATA)>
<!ELEMENT price (#PCDATA)>
<!ATTLIST price currency NMTOKEN ‘USD’>
```

Example DTD (3 of 6)

- Element content models

```
<?xml version=‘1.0’ encoding=‘ISO-8859-1’?>
<!ELEMENT order (item)+>
<!ELEMENT item (name,price)>
<!ATTLIST item code NMTOKEN #REQUIRED>
<!ELEMENT name (#PCDATA)>
<!ELEMENT price (#PCDATA)>
<!ATTLIST price currency NMTOKEN ‘USD’>
```

Example DTD (4 of 6)

- Attribute list declarations

```
<?xml version=‘1.0’ encoding=‘ISO-8859-1’?>
<!ELEMENT order (item)+>
<!ELEMENT item (name,price)>
<!ATTLIST item code NMTOKEN #REQUIRED>
<!ELEMENT name (#PCDATA)>
<!ELEMENT price (#PCDATA)>
<!ATTLIST price currency NMTOKEN ‘USD’>
```

Example DTD (5 of 6)

- Attribute value type

```
<?xml version='1.0' encoding='ISO-8859-1'?>
<!ELEMENT order (item)+>
<!ELEMENT item (name,price)>
<!ATTLIST item code NMTOKEN #REQUIRED>
<!ELEMENT name (#PCDATA)>
<!ELEMENT price (#PCDATA)>
<!ATTLIST price currency NMTOKEN 'USD'>
```

Example DTD (6 of 6)

- Attribute default value

```
<?xml version=‘1.0’ encoding=‘ISO-8859-1’?>
<!ELEMENT order (item)+>
<!ELEMENT item (name,price)>
<!ATTLIST item code NMTOKEN #REQUIRED>
<!ELEMENT name (#PCDATA)>
<!ELEMENT price (#PCDATA)>
<!ATTLIST price currency NMTOKEN ‘USD’>
```

Macro Substitution Using Entities

- ❑ What are entities?
  - Document pieces, or “storage units”
  - Simplify writing of documents and DTD grammars
  - Modularize documents and DTD grammars
- ❑ Types
  - General entities for use in document
    - Example of use: &entity;
  - Parameter entities for use in DTD
    - Example of use: %entity;

General Entities

- ❑ Declaration
  - <!ENTITY name ‘Andy Clark’>
  - <!ENTITY content SYSTEM ‘pet-peeves.ent’>
- ❑ Reference in document
  - <name>&name;</name>
  - <pet-peeves>&content;</pet-peeves>

Parameter Entities

❑ Declaration
- <!ENTITY % boolean ‘(true|false)’>
- <!ENTITY % html SYSTEM ‘html.dtd’>

❑ Reference in DTD
- <!ATTLIST person cool %boolean; #IMPLIED>
- %html;

Specifying DTD in Document

- ❑ Doctype declaration
  - *Must* appear before the root element
  - *May* contain declarations *internal* to document
  - *May* reference declarations *external* to document
- ❑ Internal subset
  - Commonly used to declare general entities
  - Overrides declarations in external subset

Doctype Example (1 of 4)

- Only internal subset

```
<?xml version=‘1.0’ encoding=‘UTF-16’?>
<!DOCTYPE root [
  <!ELEMENT root (stem)>
  <!ELEMENT stem EMPTY>
]>
<root>
  <stem/>
</root>
```

Doctype Example (2 of 4)

❑ Only external subset

- Using system identifier

```
<?xml version='1.0' encoding='UTF-16'?>
<!DOCTYPE root SYSTEM 'tree.dtd'>
<root> <stem/> </root>
```

- Using public identifier

```
<?xml version='1.0' encoding='UTF-16'?>
<!DOCTYPE root PUBLIC '-//Tree 1.0//EN'  'tree.dtd'>
<root> <stem/> </root>
```

Doctype Example (3 of 4)

- Internal *and* external subset

```
<?xml version=‘1.0’ encoding=‘UTF-16’?>
<!DOCTYPE root SYSTEM ‘tree.dtd’ [
  <!ELEMENT root (stem)>
  <!ELEMENT stem EMPTY>
]>
<root>
  <stem/>
</root>
```

Doctype Example (4 of 4)

- Syntactically legal but never used

```
<?xml version=‘1.0’ encoding=‘UTF-16’?>
<!DOCTYPE root >
<root>
  <stem/>
</root>
```

Beyond DTDs…

- ❑ DTD limitations
  - Simple document structures
  - Lack of “real” datatypes
- ❑ Advanced schema languages
  - XML Schema
  - Relax NG
  - …

XML Namespaces

The Problem

- ❑ Documents use different vocabularies
  - Example 1: CD music collection
  - Example 2: online order transaction
- ❑ Merging multiple documents together
  - Name collisions can occur

    Example 1: albums have a <name>

    Example 2: customers have a <name>
  - How do you differentiate between the two?

The Solution: Namespaces!

- ❑ What is a namespace?
  - A syntactic way to differentiate similar names in an XML document
- ❑ Binding namespaces
  - Uses Uniform Resource Identifier (URI)

    e.g. “http://example.com/NS”
  - Can bind to a named or “default” prefix

Namespace Binding Syntax

- Use “xmlns” attribute
  - Named prefix

    e.g. <a:foo xmlns:a=‘http://example.com/NS’/>
  - Default prefix

    e.g. <foo xmlns=‘http://example.com/NS’/>

- Element and attribute names are “qualified”
  - URI, local part (or “local name”) pair

    e.g. { “http://example.com/NS” , “foo” }

Example Document (1 of 3)

- Namespace binding

```
<?xml version=‘1.0’ encoding=‘UTF-8’?>
<order>
  <item code=‘BK123’>
    <name>Care and Feeding of Wombats</name>
    <desc xmlns:html=‘http://www.w3.org/1999/xhtml’>
       The <html:b>best</html:b> book ever written!
    </desc>
  </item>
</order>
```

Example Document (2 of 3)

- Namespace scope

```
<?xml version=‘1.0’ encoding=‘UTF-8’?>
<order>
  <item code=‘BK123’>
    <name>Care and Feeding of Wombats</name>
    <desc xmlns:html=‘http://www.w3.org/1999/xhtml’>
       The <html:b>best</html:b> book ever written!
    </desc>
  </item>
</order>
```

Example Document (3 of 3)

- Bound elements

```
<?xml version='1.0' encoding='UTF-8'?>
<order>
  <item code='BK123'>
    <name>Care and Feeding of Wombats</name>
    <desc xmlns:html='http://www.w3.org/1999/xhtml'>
      The <html:b>best</html:b> book ever written!
    </desc>
  </item>
</order>
```

Important Points

- ❑ Namespace “scope” is the element and descendents from point of binding
- ❑ Attributes are **not** in element’s namespace
  - Unless implicitly prefixed
- ❑ Can **not** unbind named prefixes
  - However, you *can* unbind default prefix

Using Namespaces with DTDs

- ❑ The problem
  - DTD syntax does not support namespaces
- ❑ The solution
  - Use a namespace-aware schema language
  - Use parameter entity “trick” to add simple namespace support to existing DTDs

Parameter Entity Trick: Step 1

- Define parameter entities
  - Prefix, suffix, and xmlns parameter entity

```
<!ENTITY % prefix ''>
<!ENTITY % suffix ''>
```

  - Xmlns parameter entity

```
<!ENTITY % xmlns ‘xmlns%suffix;’>
```

Parameter Entity Trick: Step 2

- Define element name parameter entities
  - One for every element name in grammar

```
<!ENTITY % order ‘%prefix;order’ >
<!ENTITY % item ‘%prefix;item’>
<!ENTITY % name ‘%prefix;name’>
<!ENTITY % price ‘%prefix;price’>
```

Parameter Entity Trick: Step 3

- Modify all element declarations to reference element names by parameter entity

```
<!ELEMENT %order; (%item;)+>
<!ELEMENT %item; (%name;,%price;)>
<!ELEMENT %name; (#PCDATA)>
<!ELEMENT %price; (#PCDATA)>
```

Parameter Entity Trick: Step 4

- ❑ Declare namespace binding attribute for all possible root elements

```
<!ATTLIST %order; %xmlns; CDATA ‘http://example.com/NS’>
```

Add Namespace Information to Existing, Un-prefixed Documents

- Existing documents gain namespace info

```
<?xml version='1.0' encoding='EBCDIC'?>
<!DOCTYPE order SYSTEM 'grammar.dtd'>
<order>
  <item code='BK123'>
    <name>Care and Feeding of Wombats</name>
    <price currency='USD'>42.00</price>
  </item>
</order>
```

Use New Prefix with Same DTD

- Redefine prefix, suffix in DTD internal subset

```
<?xml version=‘1.0’ encoding=‘EBCDIC’?>
<!DOCTYPE a:order SYSTEM ‘grammar.dtd’ [
  <!ENTITY % prefix ‘a:’>
  <!ENTITY % suffix ‘:a’>
]>
<a:order xmlns:a=‘http://example.com/NS’>
  <a:item code=‘BK123’>
  <!-- ... -->
```

Useful Links

- ❑ XML 1.0 Specification
  - http://www.w3.org/TR/REC-xml
- ❑ Annotated XML 1.0 Specification
  - http://www.xml.com/axml/testaxml.htm
- ❑ Informational web sites
  - http://www.xml.com/
  - http://www.xmlhack.com/
- ❑ Namespaces in XML Specification
  - http://www.w3.org/TR/REC-xml-names