CM0133 Internet Computing

XML
The eXtensible Markup Language

Outline

- XML and HTML
- XML applications
- XML documents and the XML data model
- XML applications
  - Documents
  - Type Declarations and Definitions
  - Stylesheets

XML and HTML

- HTML elements describe the structure of a document and the style of presentation
  - HTML elements do not indicate the meaning of the information contained in the document
- XML allows authors to create their own tags (elements)
  - tags can be used to describe the meaning of the information contained within them (i.e. within the element)
  - we can also define attributes for these tags
- XML documents represent the structure of the information
  - by allowing a hierarchical ordering of the elements
- Scripts can make sophisticated use of XML tags
  - for example, to display the information on a web browser

XML and HTML

```
<ul>
    <li>Web Programming</li>
    <li>Chris Bates</li>
    <li>John Wiley and Sons</li>
    <li>2002</li>
    <li>0-470-84371-3</li>
</ul>
```

```
<book type="technical">
    <title>Web Programming</title>
    <author>Chris Bates</author>
    <publisher>John Wiley and Sons</publisher>
    <year>2002</year>
    <ISBN>0-470-84371-3</ISBN>
</book>
```

XML

- NOTE: XML does not DO anything!
  - Created to structure, store and send information
  - HTML designed to DISPLAY data
- Why XML?
  - On internet, XML describe data, HTML display data
  - Can have multiple views of same data
  - Exchange data between incompatible systems/different platforms
  - Just exchange information in plain text files
  - B2B (Business to Business)
- Future applications all likely to exchange data in XML

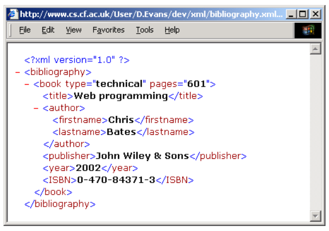
XML

- XML is a meta-language (a subset of SGML)
  - used to create custom markup languages
  - provides a basic format for structured documents
- XML allows authors to define their own elements
  - used to describe the meaning of the information they contain
  - we identify different types of information according to the meaning of that information
- There is no standard set of XML tags, but many widely-used markup languages have been created using XML
  - CML (chemical markup language)
  - MathML (mathematical markup language)
  - MusicML (musical markup language)

A simple XML Document

```
<?xml version="1.0"?>
<bibliography>
  <book type="technical" pages="601">
    <title>Web programming</title>
    <author>
      <firstname>Chris</firstname>
      <lastname>Bates</lastname>
    </author>
    <publisher>John Wiley and Sons</publisher>
    <year>2002</year>
    <ISBN>0-470-84371-3</ISBN>
  </book>
</bibliography>
```

A simple XML Document


http://www.cs.cf.ac.uk/User/D.Evans/dev/xml/bibliography.xml...

```
  <?xml version="1.0" ?>
- <bibliography>
  - <book type="technical" pages="601">
      <title>Web programming</title>
    - <author>
        <firstname>Chris</firstname>
        <lastname>Bates</lastname>
      </author>
      <publisher>John Wiley & Sons</publisher>
      <year>2002</year>
      <ISBN>0-470-84371-3</ISBN>
    </book>
  </bibliography>
```

- The file is called `bibliography.xml`
- The first line is a processing instruction which specifies the XML version used
- The `bibliography` element is composed of one or more `book` elements
- The `book` element is has child elements `title`, `author`, `publisher`, `year` and `ISBN`
- The `author` element has child elements `firstname` and `lastname`
- The `book` element has attributes `type` and `pages`

CML example

```
<?xml version="1.0"?>
 <cml xmlns="http://www.xml-cml.org/schema/cml2/core">
  <molecule id="myMolecule">
   <atomArray>
     <atom id="a1" elementType="C" hydrogenCount="0"/>
     <atom id="a2" elementType="C" hydrogenCount="0"/>
     <atom id="a3" elementType="C" hydrogenCount="2"/>
   </atomArray>
   <bondArray>
     <bond atomRefs="a1 a2" order="1"/>
     <bond atomRefs="a2 a3" order="1"/>
     <bond atomRefs="a1 a3" order="2"/>
       <stereo>W</stereo>
     </bond>
   </bondArray>
  </molecule>
 <cml>
```

MathML example

```
<?xml version="1.0"?>
<math xmlns="http://www.w3.org/1998/Math/MathML">
  <mstyle fontsize="30pt">
    <mrow>
      <msup>
        <mi>x</mi>
        <mn>2</mn>
      </msup>
      <mo>+</mo>
      <mrow>
        <mn>4</mn>
        <mo>&InvisibleTimes;</mo>
        <mi>x</mi>
      </mrow>
    </mrow>
  </mstyle>
</math>
```

XML

- XML is case sensitive
- An XML document must be well-formed
  - every opening tag must have a closing tag
  - elements must not overlap
  - all attribute values must be enclosed in quotation marks (single or double)
- XML documents are often required to obey certain rules regarding the structure of their elements
  - these rules are specified in a document type declaration
  - this leads to the concept of valid XML documents

Well-formed XML documents

- The document must have one element (the root) within which all other elements are nested
- All attribute values must be in quotation marks
- All elements must have opening and closing tags, unless empty in which case **`<tagname/>`** must be used
- All tags must be properly nested
  - opening and closing tags must be inside their parent
- Markup characters must not be used in document text
  - `<, >, &, ]]>`
- Entities must be declared in a DTD

Exercise

Pair up and write a well formed XML document for describing cars

Examples

```
<!DOCTYPE node PUBLIC "-//freedesktop//DTD
D-BUS Object Introspection 1.0//EN"

"http://www.freedesktop.org/standards/dbus/1.0/i
ntrospect.dtd">
<node name="/com/trollech/examples/car">
        <interface
name="com.trolltech.Examples.CarInterface">
                <method name="accelerate"/>
                <method name="decelerate"/>
                <method name="turnLeft"/>
                <method name="turnRight"/>
                <signal name="crashed"/>
        </interface>
</node>
```

```
class XmlExamples {
  static def CAR_RECORDS = '''
    <records>
      <car name='HSV Maloo' make='Holden' year='2006'>
        <country>Australia</country>
        <record type='speed'>Production Pickup Truck with speed of
271kph</record>
      </car>
      <car name='P50' make='Peel' year='1962'>
        <country>Isle of Man</country>
        <record type='size'>Smallest Street-Legal Car at 99cm wide and 59
kg in weight</record>
      </car>
      <car name='Royale' make='Bugatti' year='1931'>
        <country>France</country>
        <record type='price'>Most Valuable Car at $15 million</record>
      </car>
    </records>
  '''
}
```

Valid XML documents

- The document must be well formed
- The document's root element must match the root element specified in the associated DTD
- The document must have a DTD that declares all elements, attributes and entities
- The document must follow the rules (grammar) specified in the associated DTD

XML Parsers

- HTML
  - If errors in HTML then still works
  - Leads to different browsers interpreting HTML slightly differently
  - Leads to incompatibility issues between browsers
- XML
  - Decided this should not be the case. If error in XML, then program should not continue
  - XML parsers created to check well-formed XML

XML Parsers

- XML parsers construct a tree representation of the data
  - The majority of XML parsers are non-validating
  - They only check that the document is well-formed
- Browser includes an XML parser
- Other XML parsers:
  - SAX-based parsers
  - DOM-based parsers

XML applications

An XML application has three components

- An XML document
  - contains data tagged with content-specific elements
  - There is no standard set of XML tags.
- A document type definition (DTD)
  - specifies element names and attributes, and rules for the hierarchical structuring of elements.
  - There are various specifications of tags, defined in DTDs that may be public or private
- A stylesheet
  - specifies formatting rules for the document
  - either CSS (cascading stylesheet) or XLS (Extensible Stylesheet Language)

XML documents

- An XML document is described by a data model
- The data model is a tree consisting of
  - Element nodes
  - Control Nodes
    - Document Nodes
    - Processing instruction nodes
    - Comment nodes
  - Data nodes

Element nodes

An element node is created by an expression like

<eltType a$_1$="A$_1$" ... a$_n$="A$_n$">c$_1$ . . . c$_m$</eltType>

or

<eltType a$_1$="A$_1$" ... a$_n$="A$_n$"/>

- Each element node has
  - An element type: **eltType** (this is the tag name)
  - A set of attribute-value pairs: **{(a$_i$,"A$_i$")}**
  - An ordered list of children: **{c$_j$}**
- Note: each attribute **a$_i$** must be unique

Element nodes

Elements

- are used to tag the various components that comprise the logical structure of a document
- are defined in a document type definition
  - this is accessed using a document type declaration
- may contain other elements and may include attributes
- may be empty, as in **<tagName/>**

Document nodes

A document node is a particular kind of element node

```
<!doctype eltType "URL">c1 . . . cm
```

- A document node has a type but no attributes. Instead, it has an optional URL which specifies a data model for this node and its children.
- Exactly one child of a document node must be an element node (of the same type as the document type)
- The root node of the XML tree may be an anonymous document node (without a type and without a URL)
  - Such document nodes are represented by the absence of a **<!doctype>** element

Document type declarations

- A document type declaration is a single document node which defines a data model for the entire document

```
<!DOCTYPE bibliography SYSTEM "myBib.dtd">
```

- Specifies the location of a document type definition
  - In this case, the file "**myBib.dtd**"
  - The child node of the DTD is the root element of the document
  - The DTD could also be included in the XML document itself
- **SYSTEM** indicates that the file is on a local computer
  - **PUBLIC** would indicate that the DTD is publicly available
- Specifies the root element of the document
  - **bibliography** is the root element

Processing instruction nodes

A processing instruction node is always a leaf node, and only has a processing instruction associated with it

```
<? a processing instruction ?>
```

- A processing instruction is any sequence of characters, the only restriction being that the sequence may not start with the three characters **xml** (upper, lower or mixed case) followed by a space or newline.
- Instructions starting with **xml** followed by a whitespace character have special meaning.

```
<?xml a special processing instruction ?>
```

Processing instruction nodes

Processing instruction nodes contain information that can be used by application programs

- processing instructions are ignored by XML parsers

1) The following line is mandatory (specifies xml version)

```
<?xml version="1.0" ?>
```

2) The following declares that external files are required

```
<?xml version="1.0" standalone="no" ?>
```

3) The following includes a reference to an XSL stylesheet

```
<?xml-stylesheet href="mysty.xsl" type="text/xsl" ?>
```

Comment nodes

A comment node is similar to a processing instruction node – it is always a leaf node and contains only a comment

```
<!-- a comment -->
```

- Comment nodes are used to include explanatory notes for human consumption
- Processing instruction nodes are for consumption by an application
- In the XML data model there is no difference between processing instruction nodes and comment nodes

Data nodes

- A data node is always a leaf node and has only a single characteristic – the data itself

```
<aTag>
   some data
</aTag>
```

- Since all the other types of nodes have delimiters that distinguish them, data nodes don't need delimiters
  - Everything not contained between “<” and “>” is data
- Data nodes cannot be empty
  - their data characteristic must contain at least one character

Example XML document

```
<?xml version="1.0"?>
<!DOCTYPE bibliography SYSTEM "myBib.dtd">
<!-- This is my bibliography -->
<bibliography>
  <book type="technical" pages="601">
    <title>Web programming</title>
    <author>
      <firstname>Chris</firstname>
      <lastname>Bates</lastname>
    </author>
    <publisher>John Wiley and Sons</publisher>
    <year>2002</year>
    <ISBN>0-470-84371-3</ISBN>
  </book>
</bibliography>
```

Document Type Definitions (DTD)

- An XML document has neither meaning nor context without a grammar against which it can be validated
- The grammar is called a Document Type Definition
- Writing a good DTD is probably the most difficult aspect of writing an XML application
- The DTD has only a few components
  - The way that these components are assembled leads to complex structures (like the bibliography)
  - A DTD is primarily used to verify XML documents. Good practice in business etc.

Example DTD

```
<!ELEMENT bibliography (book+) >
  <!ATTLIST bibliography
    title CDATA "Bibliography">
  <!ELEMENT book (title, author+, publisher, year, ISBN)>
    <!ATTLIST book
      type (technical | biography | fiction) #REQUIRED
      pages CDATA #IMPLIED >
    <!ELEMENT title (#PCDATA)>
    <!ELEMENT author (firstname, initial*, lastname)>
      <!ELEMENT firstname (#PCDATA)>
      <!ELEMENT initial (#PCDATA)>
      <!ELEMENT lastname (#PCDATA)>
    <!ELEMENT publisher (#PCDATA)>
    <!ELEMENT year (#PCDATA)>
    <!ELEMENT ISBN (#PCDATA)>
<!ENTITY isbn "ISBN:">
```

Example DTD

- The **bibliography** element is the root element of the DTD, and contains one or more **book** elements

`book`	exactly one occurence
`book?`	zero or one occurence
`book+`	one or more occurences
`book*`	zero or more occurence

- The **book** element contains 5 child elements: `title`, `author+`, `publisher`, `year` and `ISBN`
  - these must be included in the specified order
- `(title|author+|publisher|year|ISBN)`
  - indicates that any ordering is acceptable

Example DTD

- The book element has two attributes: `type` and `pages`
  - `PCDATA`
    - indicates that the data should be parsed (by the parser)
    - data can only contain “legal” characters and defined entities
  - `CDATA`
    - indicates that the data should be ignored by the parser
    - the data can contain any characters
  - `#REQUIRED` means mandatory (must be present)
  - `#IMPLIED` means optional
- `type (technical|biography|fiction) #REQUIRED`
  - The value of the `type` attribute must be either **technical**, **biography** or **fiction**

Example DTD

- Internal entities

```
<!ENTITY isbn "ISBN:">
```

  - This defines an internal entity called `isbn`
  - Internal entities are used to create small pieces of data that are to be used repeatedly throughout the document
  - When an entity is included, its name is preceeded by an ampersand (&) and followed by a semicolon(;).
  - The entity reference `&isbn;` is replaced by the string “`ISBN:`”
  - This is exactly the same way that HTML control characters are included in docuements (e.g `&lt;` for the < character)
- External entities

```
<!ENTITY myImage SYSTEM "myImage.png" NDATA PNG>
```

  - This defines an external entity as a container for a PNG image

Cascading stylesheets

- Recall: XML does not contain display information
  - We invent tags. Therefore a browser doesn't know if e.g. <table> tag refers to HTML table or a dining table!
- Different solutions to view problem: CSS,XSL, Javascript
- Cascading stylesheets are a simple way to view XML applications on the web
- Cascading stylesheets are limited in what they can achieve – they have no support for tables or lists
- They are included using the following line:

```
<?xml-stylesheet type="text/css" href="myStyles.css"?>
```

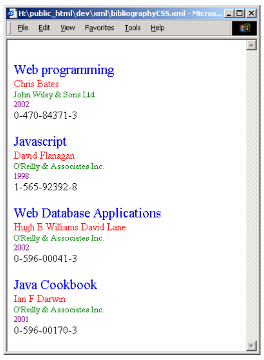
Example

```
<?xml version="1.0"?>
<!DOCTYPE bibliography SYSTEM "myBib.dtd">
<?xml-stylesheet type="text/css" href="myStyles.css"?>

<bibliography name="Bibliography for CMT602c">
  <book type="technical" pages="601">
    <title>Web programming</title>
    <author>
      <firstname>Chris</firstname>
      <lastname>Bates</lastname>
    </author>
    <publisher>John Wiley &amp; Sons Ltd</publisher>
    <year>2002</year>
    <ISBN>0-470-84371-3</ISBN>
  </book>
  ...etc...
</bibliography>
```

Cascading stylesheets

Part of `myStyles.css`

```
title {
 font-family:"times";
 font-size:16pt;
 color:blue;
 display:block;
 padding-top:15pt;
}
... etc ...

ISBN {
 family:"times";
 font-size:12pt;
 color:black;
 display:block;
}
```


H:\public_html\dev\xml\bibliographyCSS.xml - Micros...
File Edit View Favorites Tools Help

Web programming
Chris Bates
John Wiley & Sons Ltd
2002
0-470-84371-3

Javascript
David Flanagan
O'Reilly & Associates Inc.
1998
1-565-92392-8

Web Database Applications
Hugh E Williams David Lane
O'Reilly & Associates Inc.
2002
0-596-00041-3

Java Cookbook
Ian F Darwin
O'Reilly & Associates Inc.
2001
0-596-00170-3

The Extensible Stylesheet Language

- A cascading stylesheet creates a style for specific XML elements
- An XSL stylesheet creates a template – this is a design for (part of) the page
- The template is used to format XML elements which match a specified pattern
- XSL can be used to produce any type of markup
  - HTML, LaTeX, PDF, Rich Text Format
- XSL stylesheets are included using the following line:

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

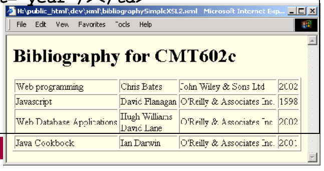
Example

```
<html>
<body bgcolor="lightyellow">
  <h1><!-- put bibliography title here --></h1>
  <table border="1">

   <!-- for every book -->
   <tr>
     <td><!-- put title here --></td>
     <td><!-- put authors here --></td>
     <td><!-- put publisher here --></td>
     <td><!-- put year here --></td>
     <td><!-- put ISBN here --></td>
   </tr>
  </table>
 </body>
</html>
```

- First write a framework for the desired output (using comments)

Example

```
<?xml version="1.0"?>
<xsl:stylesheet xmlns:xsl="http://www.w3.org/TR/WD-xsl">
 <xsl:template match="/">
  <html>
   <body bgcolor="lightyellow">
    <h1><xsl:value-of select="bibliography/@name"/></h1>
     <table border="1">
      <xsl:for-each select="bibliography/book">
       <tr>
        <td><xsl:value-of select="title"/></td>
        <td>
          <xsl:for-each select="author">
            <xsl:value-of select="firstname"/>
            <xsl:value-of select="lastname"/><br/>
           </xsl:for-each>
        </td>
        <td><xsl:value-of select="publisher"/></td>
        <td><xsl:value-of select="year"/></td>
       </tr>
      </xsl:for-each>
     </table>
   </body>
  </html>
 </xsl:template>
</xsl:stylesheet>
```


H:\public_html\dev\xml\bibliographySimpleXSL2.xml Microsoft Internet Exp...
File Edit View Favorites Tools Help

Bibliography for CMT602c

Web programming	Chris Bates	John Wiley & Sons Ltd	2002
Javascript	David Flanagan	O'Reilly & Associates Inc.	1998
Web Database Applications	Hugh Williams David Lane	O'Reilly & Associates Inc.	2002
Java Cookbook	Ian Darwin	O'Reilly & Associates Inc.	2001

XSL

- The following line declares that the file is a stylesheet

```
<xsl:stylesheet xmlns:xsl="http://www.w3.org/TR/WD-xsl">
```

- The following line declares an XSL template

```
<xsl:template match="/">
```

- A stylesheet can contain multiple templates for use in different situations. This example defines a single template (which is applied to the whole document) using the pattern matching command `match`
- Any element matching the pattern will be subject to the transformations it includes

XSL

- The XML document is represented as a hierarchy of patterns (each separated by a forward slash)
- The following line iterates over all books

```
<xsl:for-each select="bibliography/book">
```

- The following line extracts the value of the book title

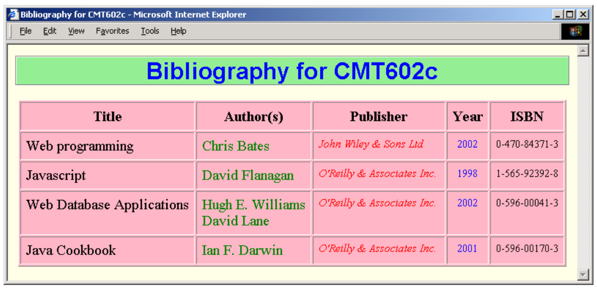
```
<xsl:value-of select="title"/>
```

- The tag is substituted in the output by the value
- The following line extracts the name attribute of the bibliography

```
<xsl:value-of select="bibliography/@name"/>
```

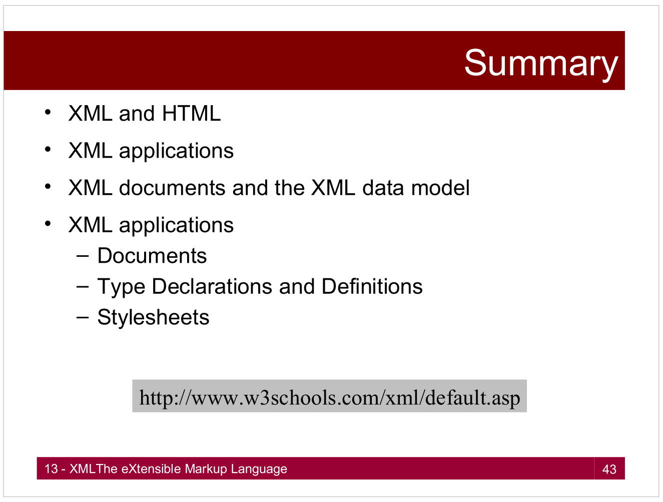
Example

- Using the attributes of the HTML elements (including style attributes) we can produce more complex presentations


Bibliography for CMT602c - Microsoft Internet Explorer
File Edit View Favorites Tools Help

Bibliography for CMT602c

Title	Author(s)	Publisher	Year	ISBN
Web programming	Chris Bates	John Wiley & Sons Ltd	2002	0-470-84371-3
Javascript	David Flanagan	O'Reilly & Associates Inc.	1998	1-565-92392-8
Web Database Applications	Hugh E. Williams David Lane	O'Reilly & Associates Inc.	2002	0-596-00041-3
Java Cookbook	Ian F. Darwin	O'Reilly & Associates Inc.	2001	0-596-00170-3


Summary

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http://www.w3schools.com/xml/default.asp