core WEB programming

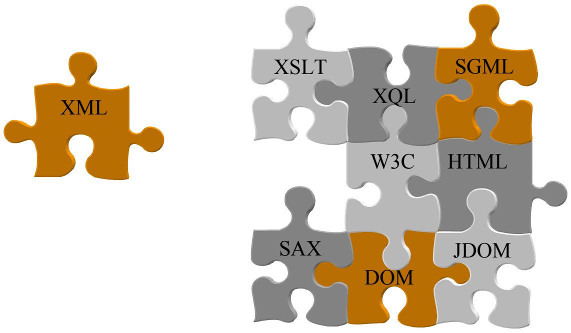
Introduction to XML

Agenda

- XML overview
- XML components
- Document Type Definition
- Specifying data elements (tags)
- Defining attributes and entities
- A look at XML schema

XML Overview

- **When people refer to XML, they typically are referring to XML and related technologies**



XML Resources

- **XML 1.0 Specification**
  - http://www.w3.org/TR/REC-xml
- **WWW consortium's Home Page on XML**
  - http://www.w3.org/XML/
- **Sun Page on XML and Java**
  - http://java.sun.com/xml/
- **Apache XML Project**
  - http://xml.apache.org/
- **XML Resource Collection**
  - http://xml.coverpages.org/
- **O'Reilly XML Resource Center**
  - http://www.xml.com/

XML Overview

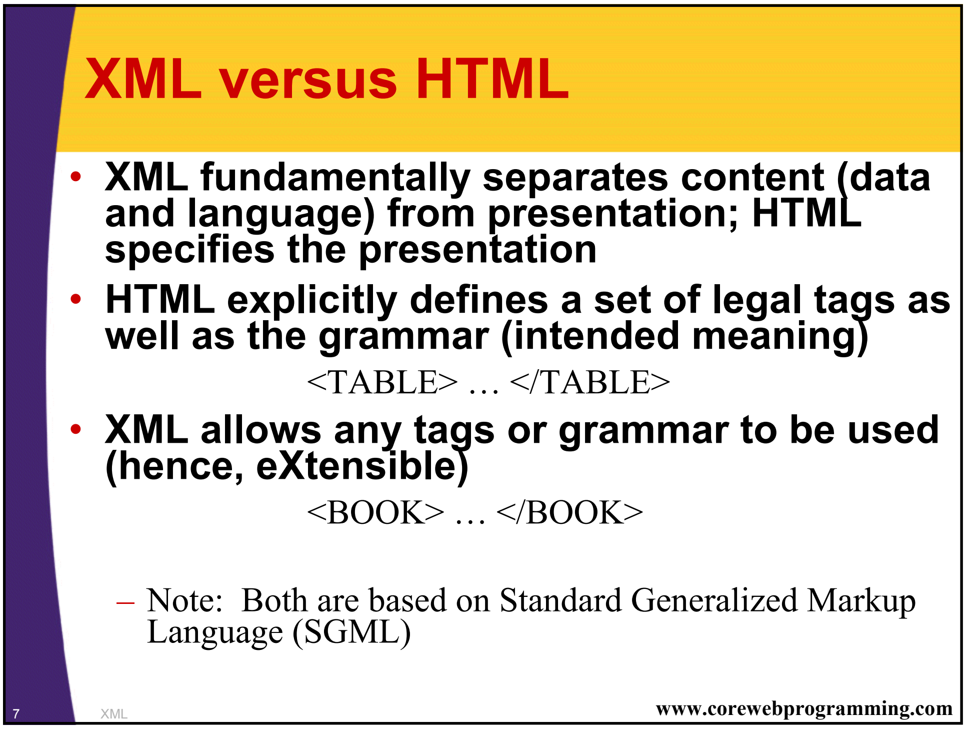
- **EXtensible Markup Language (XML) is a meta-language that describes the content of the document (self-describing data)**

  Java = Portable Programs
  XML = Portable Data

- **XML does not specify the tag set or grammar of the language**
  - Tag Set – markup tags that have meaning to a language processor
  - Grammar – defines correct usage of a language's tag

Applications of XML

- **Configuration files**
  - Used extensively in J2EE architectures
- **Media for data interchange**
  - A better alternative to proprietary data formats
- **B2B transactions on the Web**
  - Electronic business orders (ebXML)
  - Financial Exchange (IFX)
  - Messaging exchange (SOAP)



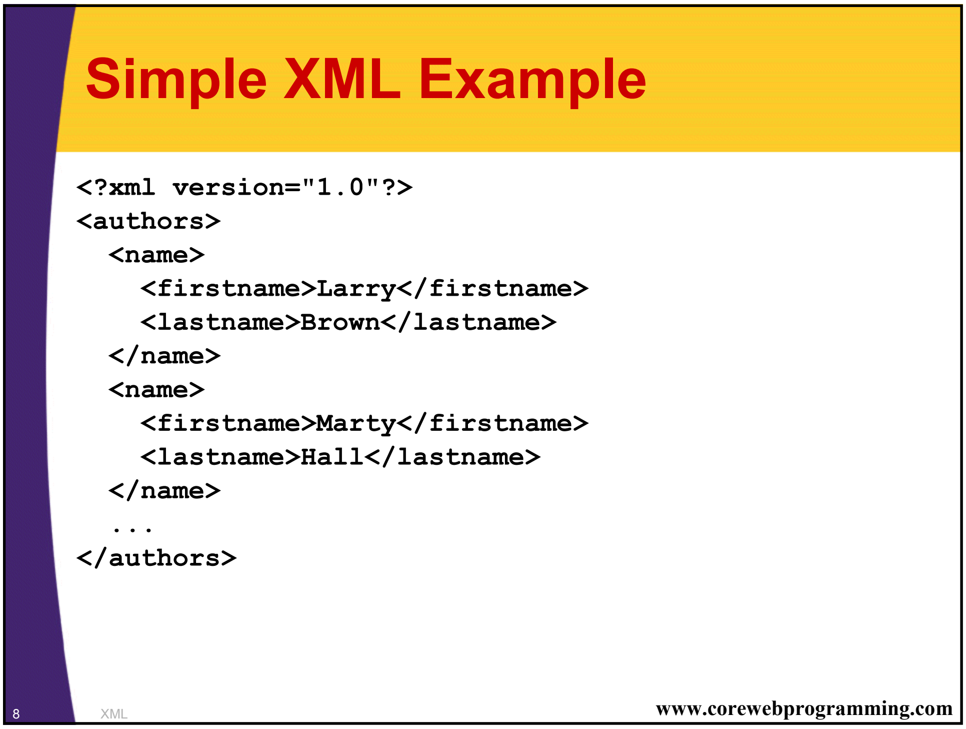
XML versus HTML

- XML fundamentally separates content (data and language) from presentation; HTML specifies the presentation
- HTML explicitly defines a set of legal tags as well as the grammar (intended meaning)

  <TABLE> … </TABLE>
- XML allows any tags or grammar to be used (hence, eXtensible)

  <BOOK> … </BOOK>

  – Note: Both are based on Standard Generalized Markup Language (SGML)



Simple XML Example

```
<?xml version="1.0"?>
<authors>
  <name>
    <firstname>Larry</firstname>
    <lastname>Brown</lastname>
  </name>
  <name>
    <firstname>Marty</firstname>
    <lastname>Hall</lastname>
  </name>
  ...
</authors>
```

XML Components

- **Prolog**
  - Defines the xml version, entity definitions, and DOCTYPE
- **Components of the document**
  - Tags and attributes
  - CDATA (character data)
  - Entities
  - Processing instructions
  - Comments

XML Prolog

- **XML Files always start with a prolog**

```
<?xml version="1.0" encoding="ISO-8859-1" standalone="no"?>
```

  - The `version` of XML is required
  - The `encoding` identifies character set (default UTF-8)
  - The value `standalone` identifies if an *external* document is referenced for DTD or entity definition

  - Note: the prolog can contain entities and DTD definitions

Prolog Example

```
<?xml version="1.0" standalone="yes"?>
<DOCTYPE authors [
<!ELEMENT authors (name)*>
<!ELEMENT name (firstname, lastname)>
<!ELEMENT firstname (#PCDATA)>
<!ELEMENT lastname (#PCDATA)>
]>
<authors>
  <name>
    <firstname>James</firstname>
    <lastname>Gosling</lastname>
  </name>
  ...
</authors>
```

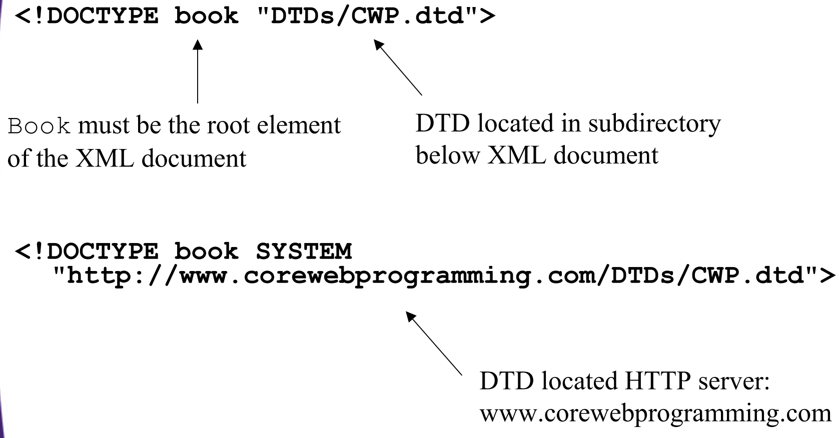
XML DOCTYPE

- **Document Type Declarations**
  - Specifies the location of the DTD defining the syntax and structure of elements in the document
  - Common forms:

```
<!DOCTYPE root [DTD]>
<!DOCTYPE root SYSTEM URL>
<!DOCTYPE root PUBLIC FPI-identifier URL>
```

  - The `root` identifies the starting element (root element) of the document
  - The DTD can be external to the XML document, referenced by a `SYSTEM` or `PUBLIC` URL
    - `SYSTEM` URL refers to a private DTD
      - Located on the local file system or HTTP server
    - `PUBLIC` URL refers to a DTD intended for public use

DOCTYPE Examples



```
<!DOCTYPE book "DTDs/CWP.dtd">
```

`Book` must be the root element of the XML document

DTD located in subdirectory below XML document

```
<!DOCTYPE book SYSTEM
   "http://www.corewebprogramming.com/DTDs/CWP.dtd">
```

DTD located HTTP server: www.corewebprogramming.com

XML DOCTYPE, cont.

- **Specifying a PUBLIC DTD**

  `<!DOCTYPE root PUBLIC` *`FPI-identifier URL`*`>`

  – The Formal Public Identifier (FPI) has four parts:

    1. Connection of DTD to a formal standard
       - if defining yourself
       + nonstandards body has approved the DTD
       `ISO` if approved by formal standards committee
    2. Group responsible for the DTD
    3. Description and type of document
    4. Language used in the DTD

PUBLIC DOCTYPE Examples

```
<!DOCTYPE Book
   PUBLIC "-//W3C//DTD XHMTL 1.0 Transitional//EN"
   "http://www.w3.org/TR?xhtml1/DTD/xhtml1-transitional.dtd">

<!DOCTYPE CWP
   PUBLIC "-//Prentice Hall//DTD Core Series 1.0//EN"
   "http://www.prenticehall.com/DTD/Core.dtd">
```

XML Comments

- Comments are the same as HTML comments

```
<!-- This is an XML and HTML comment -->
```

Processing Instructions

- Application-specific instruction to the XML processor

```
<?processor-instruction?>
```

- Example

```
<?xml version="1.0" ?>
<?xml-stylesheet type="text/xml" href="orders.xsl" ?>
<orders>
  <order>
    <count>37</count>
    <price>49.99</price>
    <book>
      <isbn>0130897930</isbn>
      <title>Core Web Programming Second Edition</title>
      <authors>
        <author>Marty Hall</author>
        <author>Larry Brown</author>
      </authors>
    </book>
  </order>
</orders>
```

XML Root Element

- Required for XML-aware applications to recognize beginning and end of document
- Example

```
<?xml version="1.0" ?>
<book>
  <title>Core Web Programming</title>
  <contents>
    <chapter number="1">
      Designing Web Pages with HTML
    </chapter>
    <chapter number="2">
      Block-level Elements in HTML 4.0
    </chapter>
    <chapter number="3">
      Text-level Elements in HTML 4.0
    </chapter>
    ...
  </contents>
</book>
```

XML Tags

- **Tag names:**
  - Case sensitive
  - Start with a letter or underscore
  - After first character, numbers, `-` and `.` are allowed
  - Cannot contain whitespaces
  - Avoid use of colon expect for indicating namespaces
- **For a well-formed XML documents**
  - Every tag must have an end tag

```
<elementOne> … </elementOne>
<elementTwo />
```

  - All tags are completely nested (tag order cannot be mixed)

XML Tags, cont.

- **Tags can also have attributes**

```
<message to="Gates@microsoft.com" from="Gosling@sun.com">
  <priority/>
  <text>We put the . in .com.
        What did you do?
  </text>
</message>
```

XML Attributes

- **Element Attributes**
  - Attributes provide metadata for the element
  - Every attribute must be enclosed in "" with no commas in between
  - Same naming conventions as elements

Using Tag Attributes

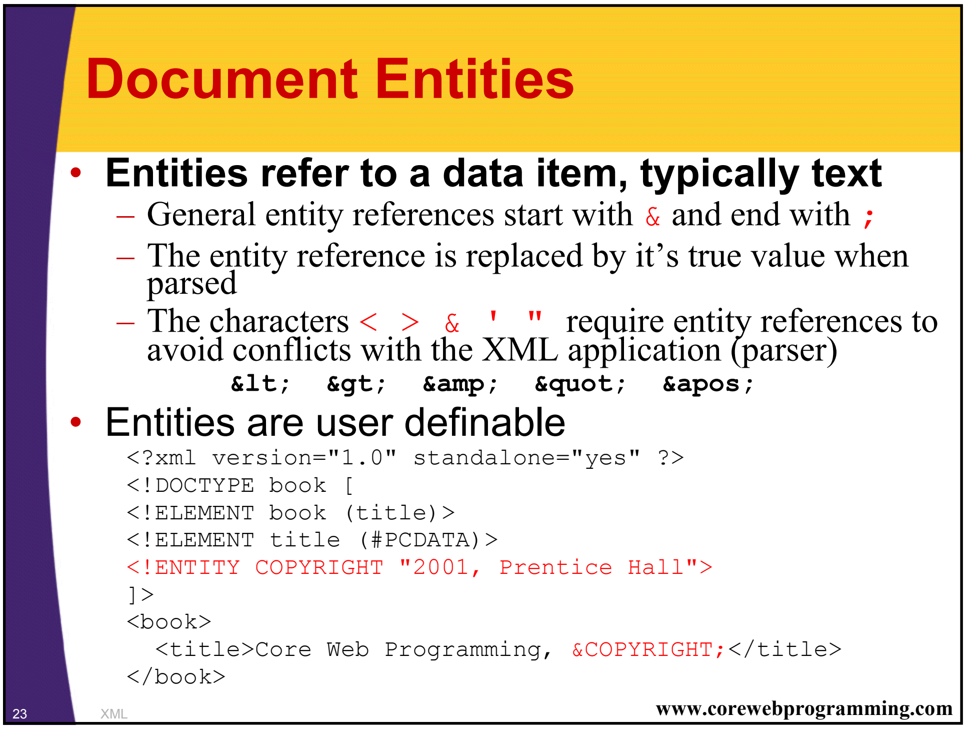
- **The general rule is:**
  - Use elements for *presentable* data and attributes for *system* data
    - Case I (preferred design)

```
<chapter number="23" focus="Server-side programming">
    XML Processing with Java
</chapter>
```

    - Case II

```
<chapter>
  <number>23</number>
  <focus>Server-side programming</focus>
  <title>XML Processing with Java</title>
</chapter>
```

  - Note, however, not all XML technologies handle attributes well
    - A document will no attributes diminishes clarity and meaning, but is easier to process

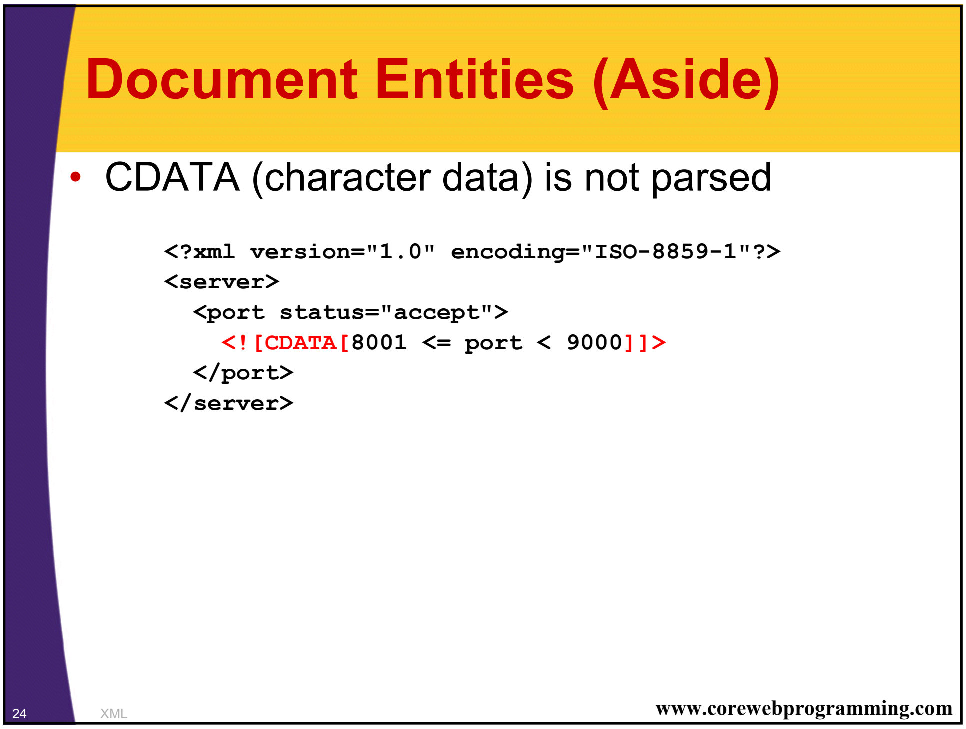


Document Entities

- **Entities refer to a data item, typically text**
  - General entity references start with & and end with ;
  - The entity reference is replaced by it’s true value when parsed
  - The characters < > & ' " require entity references to avoid conflicts with the XML application (parser)

    &lt; &gt; &amp; &quot; &apos;
- Entities are user definable

```
<?xml version="1.0" standalone="yes" ?>
<!DOCTYPE book [
<!ELEMENT book (title)>
<!ELEMENT title (#PCDATA)>
<!ENTITY COPYRIGHT "2001, Prentice Hall">
]>
<book>
  <title>Core Web Programming, &COPYRIGHT;</title>
</book>
```



Document Entities (Aside)

- CDATA (character data) is not parsed

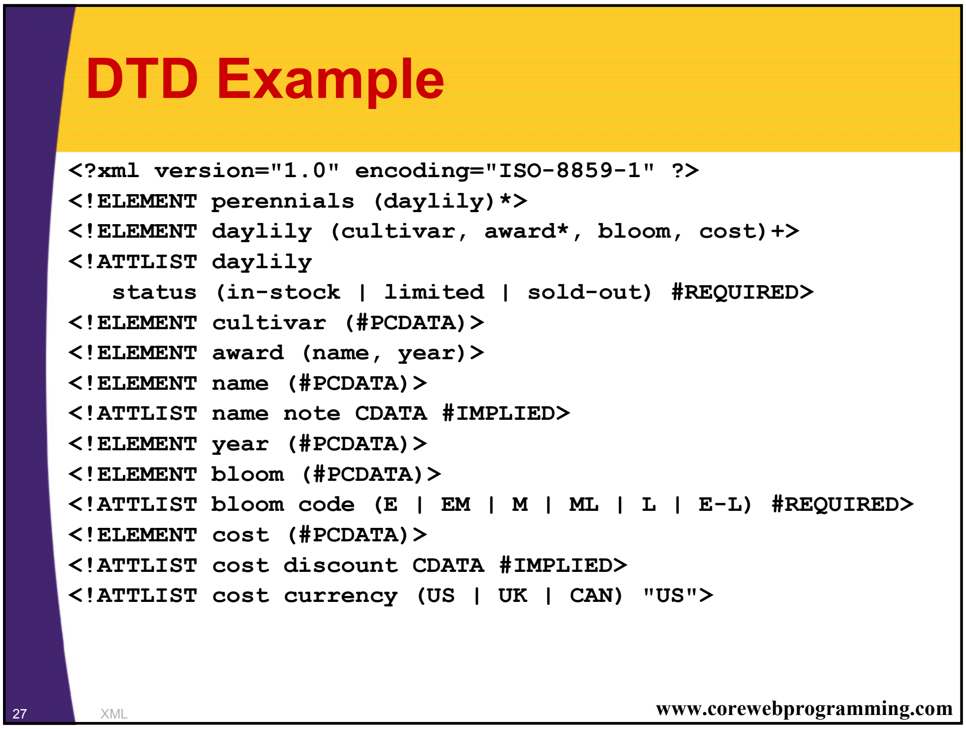
```
<?xml version="1.0" encoding="ISO-8859-1"?>
<server>
  <port status="accept">
    <![CDATA[8001 <= port < 9000]]>
  </port>
</server>
```

Well-Formed versus Valid

- **An XML document can be *well-formed* if it follows basic syntax rules**
- **An XML document is *valid* if its structure matches a Document Type Definition (DTD)**

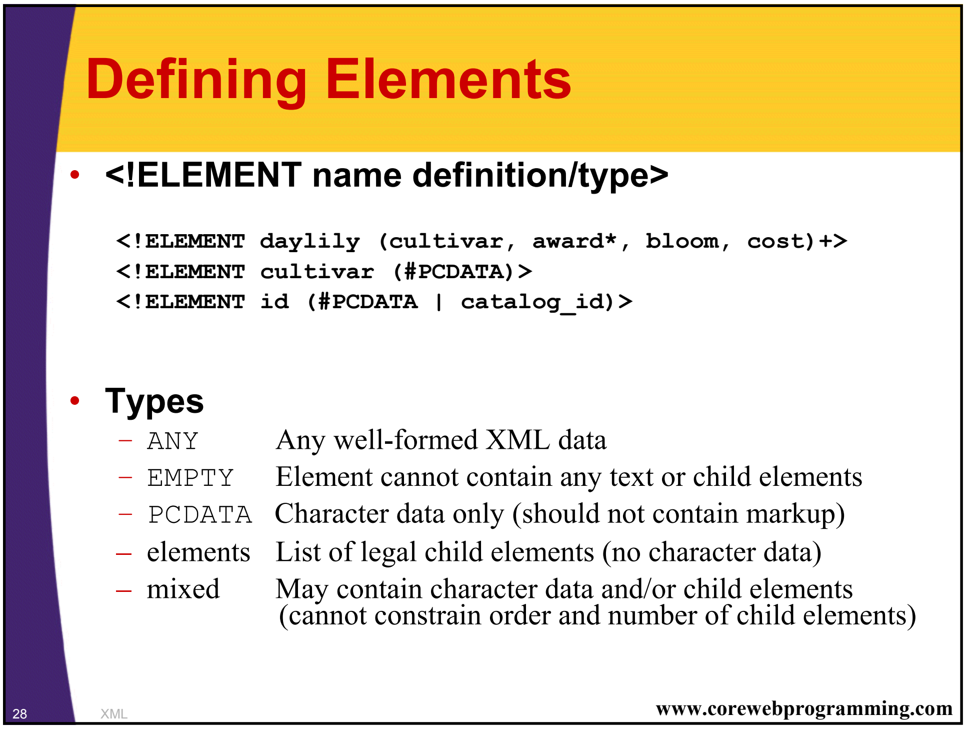
Document Type Definition (DTD)

- **Defines Structure of the Document**
  - Allowable tags and their attributes
  - Attribute values constraints
  - Nesting of tags
  - Number of occurrences for tags
  - Entity definitions



DTD Example

```
<?xml version="1.0" encoding="ISO-8859-1" ?>
<!ELEMENT perennials (daylily)*>
<!ELEMENT daylily (cultivar, award*, bloom, cost)+>
<!ATTLIST daylily
   status (in-stock | limited | sold-out) #REQUIRED>
<!ELEMENT cultivar (#PCDATA)>
<!ELEMENT award (name, year)>
<!ELEMENT name (#PCDATA)>
<!ATTLIST name note CDATA #IMPLIED>
<!ELEMENT year (#PCDATA)>
<!ELEMENT bloom (#PCDATA)>
<!ATTLIST bloom code (E | EM | M | ML | L | E-L) #REQUIRED>
<!ELEMENT cost (#PCDATA)>
<!ATTLIST cost discount CDATA #IMPLIED>
<!ATTLIST cost currency (US | UK | CAN) "US">
```



Defining Elements

- **<!ELEMENT name definition/type>**

```
<!ELEMENT daylily (cultivar, award*, bloom, cost)+>
<!ELEMENT cultivar (#PCDATA)>
<!ELEMENT id (#PCDATA | catalog_id)>
```

- **Types**
  - ANY Any well-formed XML data
  - EMPTY Element cannot contain any text or child elements
  - PCDATA Character data only (should not contain markup)
  - elements List of legal child elements (no character data)
  - mixed May contain character data and/or child elements (cannot constrain order and number of child elements)

Defining Elements, cont.

- **Cardinality**
  - `[none]` Default (one and only one instance)
  - `?` 0, 1
  - `*` 0, 1, …, N
  - `+` 1, 2, …, N
- **List Operators**
  - `,` Sequence (in order)
  - `|` Choice (one of several)

Grouping Elements

- **Set of elements can be grouped within parentheses**
  - `(Elem1?, Elem2?)+`
    - `Elem1` can occur 0 or 1 times followed by 0 or 1 occurrences of `Elem2`
    - The group (sequence) must occur 1 or more times
- **OR**
  - `((Elem1, Elem2) | Elem3)*`
    - Either the group of `Elem1`, `Elem2` is present (in order) or `Elem3` is present, 0 or more times

Element Example

```
<?xml version="1.0" standalone="yes"?>
<!DOCTYPE Person [
<!ELEMENT Person ( (Mr|Ms|Miss)?, FirstName,
          MiddleName*, LastName, (Jr|Sr)? )>
<!ELEMENT FirstName (#PCDATA)>
<!ELEMENT MiddleName (#PCDATA)>
<!ELEMENT LastName (#PCDATA)>
<!ELEMENT Mr EMPTY>
<!ELEMENT Ms EMPTY>
...
<!ELEMENT Sr EMPTY>
]>
<Person>
  <Mr/>
  <FirstName>Lawrence</FirstName>
  <LastName>Brown</LastName>
</Person>
```

Defining Attributes

- <!ATTLIST element attrName type modifier>
- Examples

```
<!ELEMENT Customer  (#PCDATA )>
<!ATTLIST Customer id CDATA  #IMPLIED>

<!ELEMENT Product (#PCDATA )>
<!ATTLIST Product
          cost CDATA  #FIXED "200"
          id   CDATA  #REQUIRED>
```

Attribute Types

- **CDATA**
  - Essentially anything; simply unparsed data

    ```
    <!ATTLIST Customer id CDATA  #IMPLIED>
    ```
- **Enumeration**
  - attribute (value1|value2|value3) [Modifier]
- **Eight other attribute types**
  - `ID`, `IDREF`, `NMTOKEN`, `NMTOKENS`, `ENTITY`, `ENTITIES`, `NOTATION`

Attribute Modifiers

- **`#IMPLIED`**
  - Attribute is not required

    ```
    <!ATTLIST cost discount CDATA #IMPLIED>
    ```
- **`#REQUIRED`**
  - Attribute must be present

    ```
    <!ATTLIST account balance CDATA #REQUIRED>
    ```
- **`#FIXED "`*`value`*`"`**
  - Attribute is present and always has this value

    ```
    <!ATTLIST interpreter language CDATA #FIXED "EN">
    ```
- **Default value (applies to enumeration)**

  ```
  <!ATTLIST car color (red | white | blue) "white" )
  ```

Defining Entities

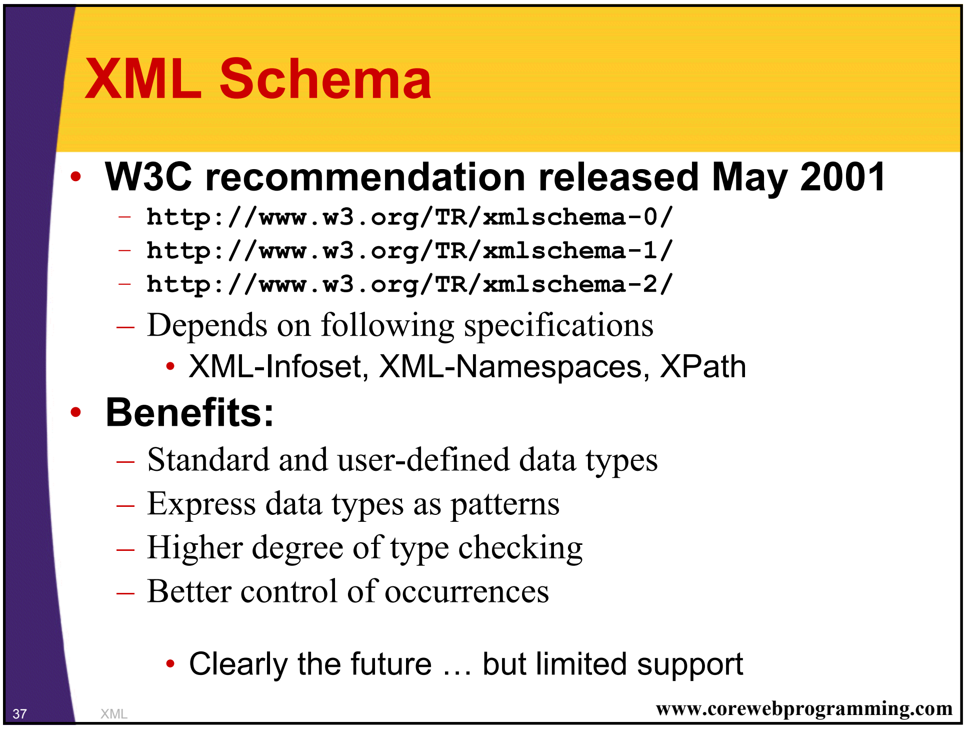
- <!ENTITY name "*replacement*">

```
<!ENTITY &amp; "&">
<!ENTITY copyright "Copyright 2001">
```

Limitations of DTDs

- DTD itself is not in XML format – more work for parsers
- Does not express data types (weak data typing)
- No namespace support
- Document can override external DTD definitions
- No DOM support

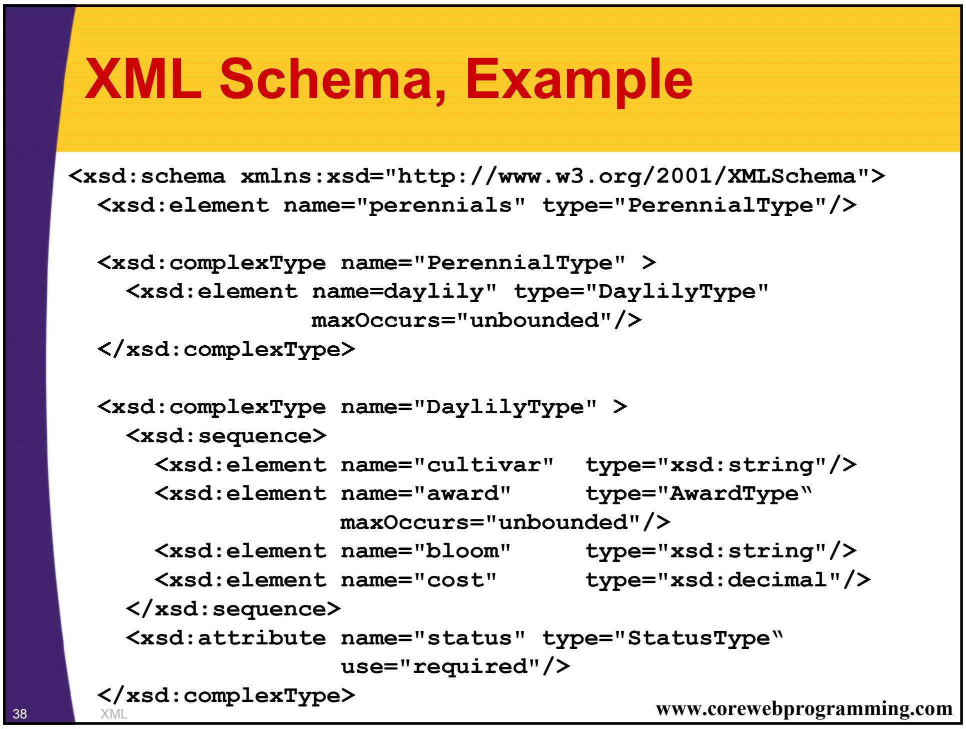
- XML Schema is intended to resolve these issues but … DTDs are going to be around for a while



XML Schema

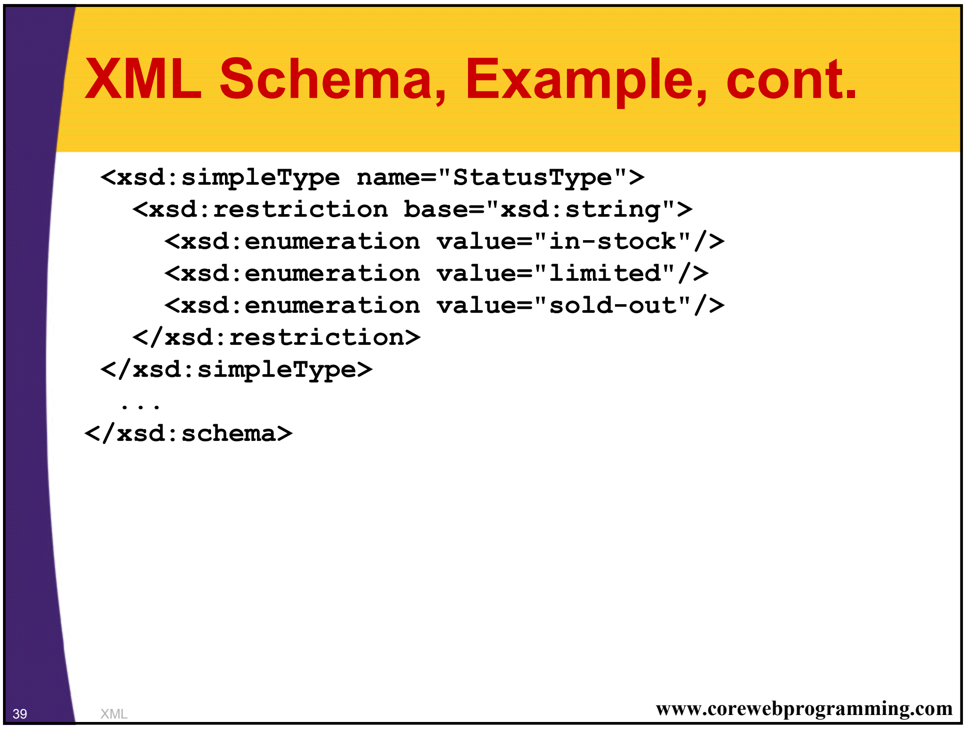
- **W3C recommendation released May 2001**
  - `http://www.w3.org/TR/xmlschema-0/`
  - `http://www.w3.org/TR/xmlschema-1/`
  - `http://www.w3.org/TR/xmlschema-2/`
  - Depends on following specifications
    - XML-Infoset, XML-Namespaces, XPath
- **Benefits:**
  - Standard and user-defined data types
  - Express data types as patterns
  - Higher degree of type checking
  - Better control of occurrences

    - Clearly the future … but limited support



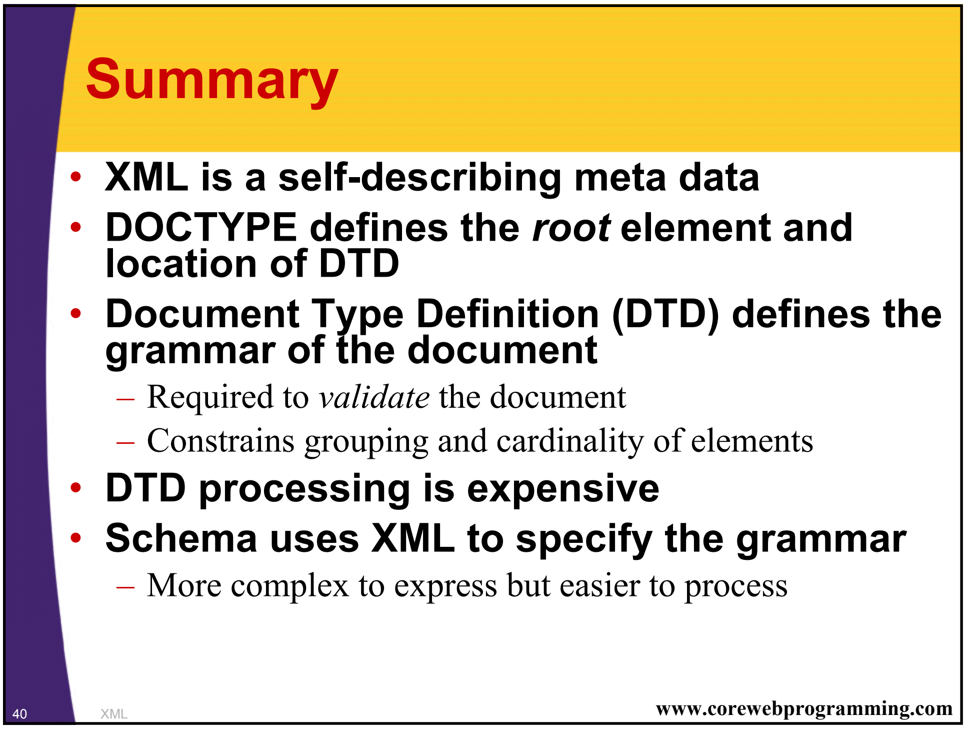
XML Schema, Example

```
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema">
  <xsd:element name="perennials" type="PerennialType"/>

  <xsd:complexType name="PerennialType" >
    <xsd:element name=daylily" type="DaylilyType"
                 maxOccurs="unbounded"/>
  </xsd:complexType>

  <xsd:complexType name="DaylilyType" >
    <xsd:sequence>
      <xsd:element name="cultivar"  type="xsd:string"/>
      <xsd:element name="award"     type="AwardType‟
                   maxOccurs="unbounded"/>
      <xsd:element name="bloom"     type="xsd:string"/>
      <xsd:element name="cost"      type="xsd:decimal"/>
    </xsd:sequence>
    <xsd:attribute name="status" type="StatusType‟
                   use="required"/>
  </xsd:complexType>
```



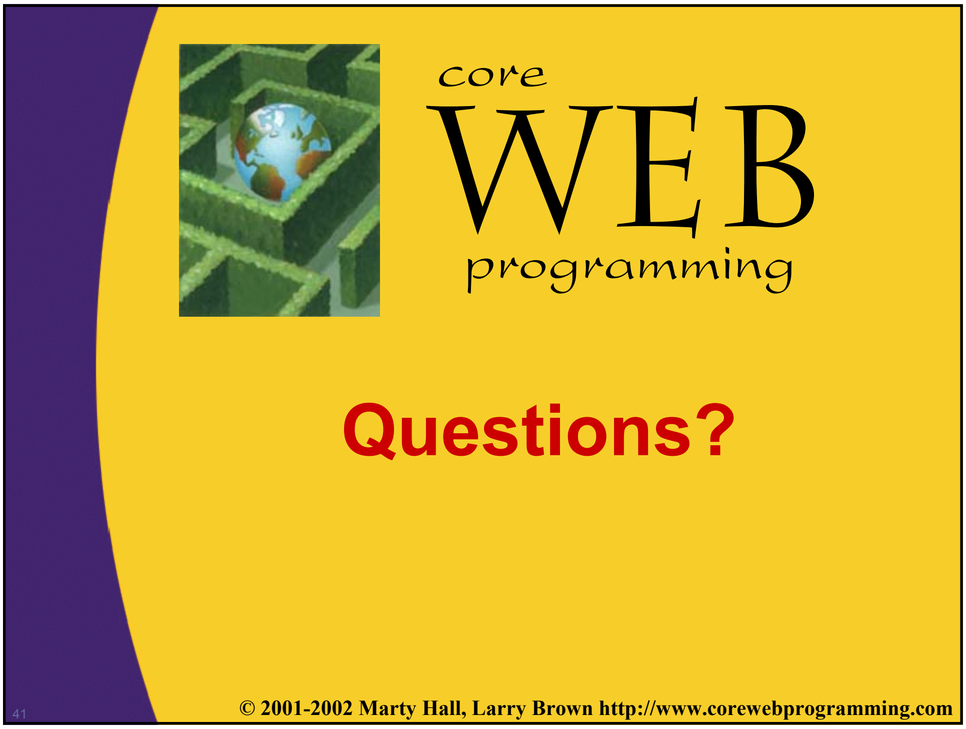
XML Schema, Example, cont.

```
 <xsd:simpleType name="StatusType">
   <xsd:restriction base="xsd:string">
     <xsd:enumeration value="in-stock"/>
     <xsd:enumeration value="limited"/>
     <xsd:enumeration value="sold-out"/>
   </xsd:restriction>
 </xsd:simpleType>
  ...
</xsd:schema>
```



Summary

- **XML is a self-describing meta data**
- **DOCTYPE defines the *root* element and location of DTD**
- **Document Type Definition (DTD) defines the grammar of the document**
  - Required to *validate* the document
  - Constrains grouping and cardinality of elements
- **DTD processing is expensive**
- **Schema uses XML to specify the grammar**
  - More complex to express but easier to process



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Questions?