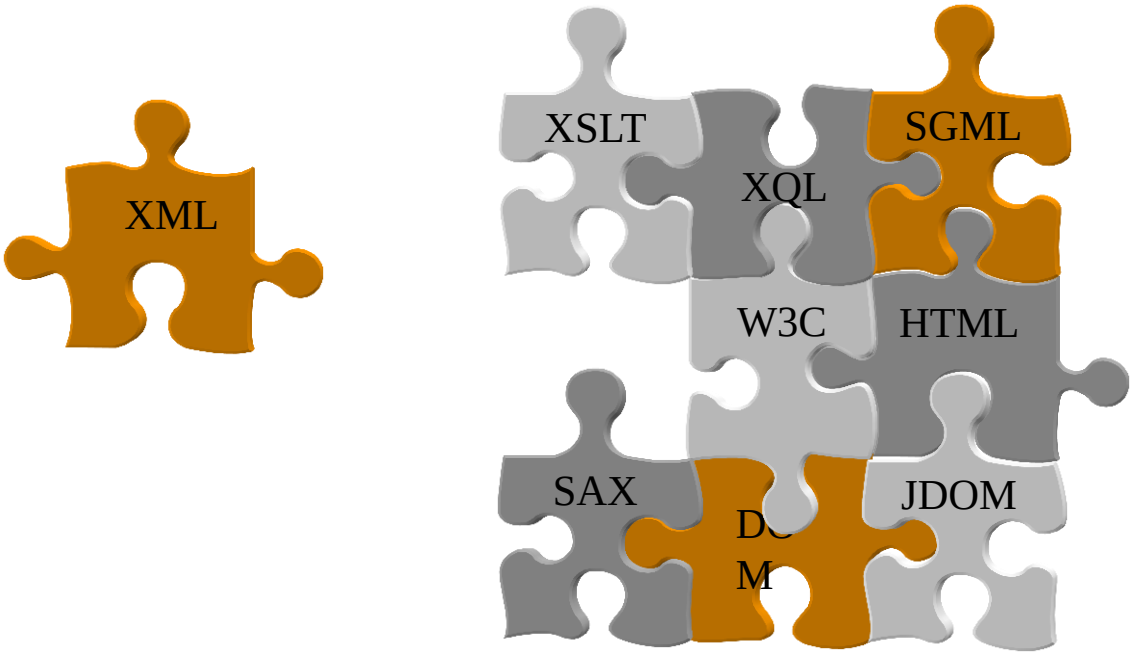
# Session 8 - XML

# Introduction to XML

- 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 Definition**
  - 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

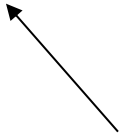
```
<!DOCTYPE book "DTDs/CWP.dtd">
```

`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">

<!DOCYTPE 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>
    <total-price>1849.63</total-price>
   <book>
      <count>37</count>
     <price>49.99</price>
     <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)

    **`<  >  &  &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**
  - `ID` Identifier
  - `IDREF`
  - `IDREFS` ID reference
  - `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, IDREFS, 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

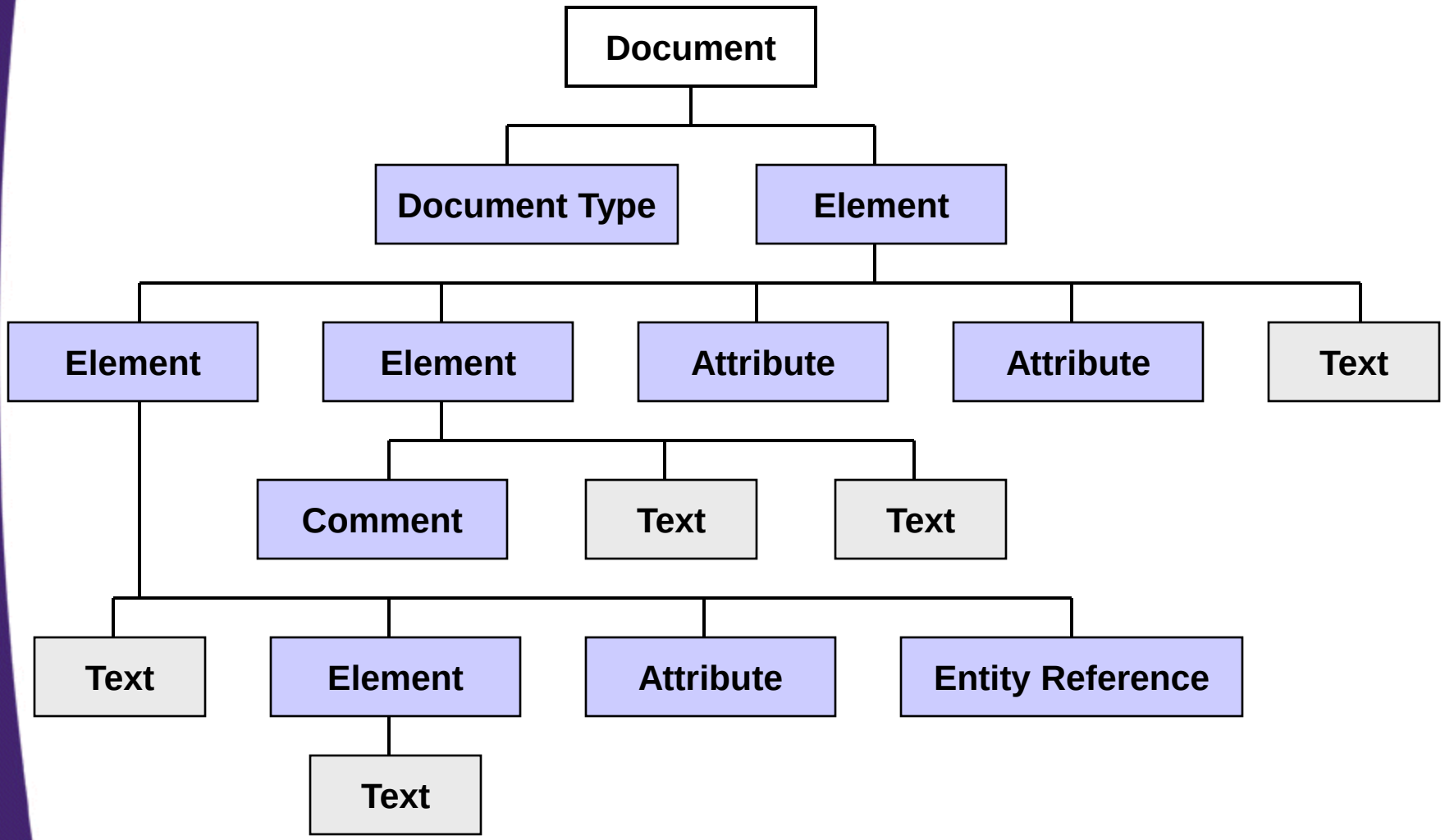
# Document Object Model

- **Introduction to DOM**
- **Java API for XML Parsing (JAXP)**
- **Installation and setup**
- **Steps for DOM parsing**
- **Example**
  - Representing an XML Document as a JTree
- **DOM or SAX?**

# Document Object Model (DOM)

- **DOM supports navigating and modifying XML documents**
  - Hierarchical tree representation of document
    - Tree follows standard API
    - Creating tree is vendor specific
- **DOM is a language-neutral specification**
  - Bindings exists for Java, C++, CORBA, JavaScript
- **DOM Versions**
  - DOM 1.0 (1998)
  - DOM 2.0 Core Specification (2000)
  - Official Website for DOM
    - `http://www.w3c.org/DOM/`

# DOM Tree


Document
Document Type
Element
Element
Element
Attribute
Attribute
Text
Comment
Text
Text
Text
Element
Attribute
Entity Reference
Text

# Exercise

- **Given some API for DOM**

  Node is object for all elements in XML file. Node has some methods as follows:

  - getChildNodes(): return NodeList
  - getNodeValue(): return value of Node
  - getNodeType(): return ELEMENT_NODE, DOCUMENT_NODE, TEXT_NODE
  - getNodeName(): return name of current node

# Solution

```
void InOrder(Node root){
    if (root.getNodeType() != Node.TEXT_NODE){
        NodeList list = root.getChildNodes();
        if (list.getLength() > 0)
            InOrder(list.item(0));
        System.out.print(root.getNodeName());
        for(int i = 1; i < list.getLength(); i++)
            InOrder(list.item(i));
    }
    else
        System.out.print(root.getNodeValue());
}
```

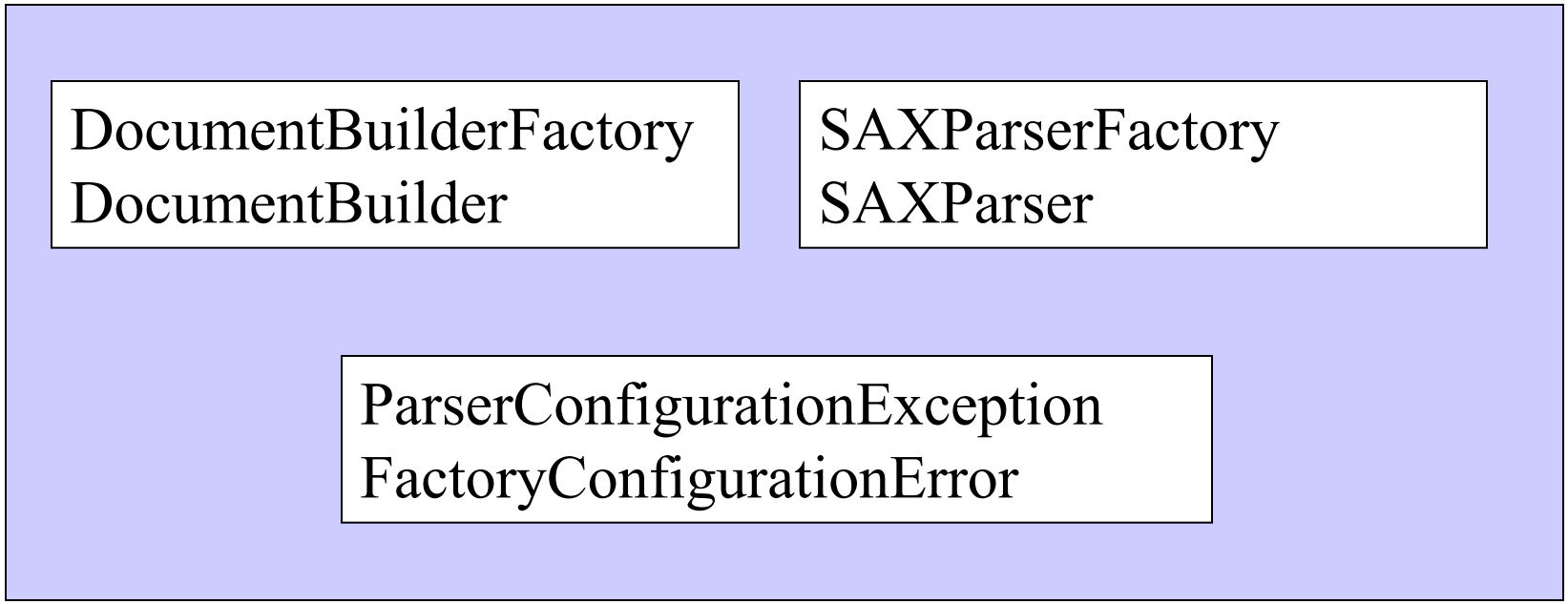
# DOM Advantages and Disadvantages

- **Advantages**
  - Robust API for the DOM tree
  - Relatively simple to modify the data structure and extract data
- **Disadvantages**
  - Stores the entire document in memory
  - As DOM was written for any language, method naming conventions don't follow standard Java programming conventions

# Java API for XML Parsing (JAXP)

- **JAXP provides a vendor-neutral interface to the underlying DOM or SAX parser**

**`javax.xml.parsers`**



# DOM Installation and Setup

1. **Download a DOM-compliant parser**
   - Java-based DOM parsers at `http://www.xml.com/pub/rg/Java_Parsers`
   - Recommend Apache Xerces-J parser at `http://xml.apache.org/xerces-j/`
2. **Download the Java API for XML Processing (JAXP)**
   - JAXP is a small layer on top of DOM which supports specifying parsers through system properties versus hard coded
   - See `http://java.sun.com/xml/`
   - Note: Apache Xerces-J already incorporates JAXP

# DOM Installation and Setup (continued)

## 3. Set your `CLASSPATH` to include the DOM (and JAXP) classes

```
set CLASSPATH=xerces_install_dir\xerces.jar;
              %CLASSPATH%
```

or

```
setenv CLASSPATH xerces_install_dir/xerces.jar:
                 $CLASSPATH
```

- For servlets, place `xerces.jar` in the server's `lib` directory
  - Note: Tomcat 4.0 is prebundled with `xerces.jar`
- Xerces-J already incorporates JAXP
  - For other parsers you may need to add `jaxp.jar` to your classpath and servlet `lib` directory

# Aside: Using Xerces with Tomcat 3.2.x

- **Problem**
  - Tomcat 3.2.x may load the provided DOM Level 1 parser first (`parser.jar`) before `xerces.jar`, effectively eliminating namespace support required in DOM Level 2

- **Solutions**
  1. Set up a static `CLASSPATH` and place `xerces.jar` *first* in the list
  2. As the files are loaded alphabetically, rename `parser.jar` to `z_parser.jar` and `xml.jar` to `z_xml.jar`

# DOM Installation and Setup (continued)

## 4. Bookmark the DOM Level 2 and JAXP APIs

- DOM Level 2
  - `http://www.w3.org/TR/DOM-Level-2-Core/`
- JAXP
  - `http://java.sun.com/xml/jaxp/dist/1.1/docs/api/index.html`

# Steps for DOM Parsing

1. Tell the system which parser you want to use
2. Create a JAXP document builder
3. Invoke the parser to create a Document representing an XML document
4. Normalize the tree
5. Obtain the root node of the tree
6. Examine and modify properties of the node

# Step 1: Specifying a Parser

- **Approaches to specify a parser**
  - Set a system property for `javax.xml.parsers.DocumentBuilder-Factory`
  - Specify the parser in `jre_dir/lib/jaxp.properties`
  - Through the J2EE Services API and the class specified in `META-INF/services/javax.xml.parsers. DocumentBuilder-Factory`
  - Use system-dependant default parser (check documentation)

# Specifying a Parser, Example

- **The following example:**
  - Permits the user to specify the parser through the command line `-D` option

```
java -Djavax.xml.parser.DocumentBuilderFactory =
     com.sun.xml.parser.DocumentBuilderFactoryImpl ...
```

  - Uses the Apache Xerces parser otherwise

```
public static void main(String[] args) {
  String jaxpPropertyName =
    "javax.xml.parsers.DocumentBuilderFactory";
  if (System.getProperty(jaxpPropertyName) == null) {
    String apacheXercesPropertyValue =
      "org.apache.xerces.jaxp.DocumentBuilderFactoryImpl";
    System.setProperty(jaxpPropertyName,
                       apacheXercesPropertyValue);
  }
  ...
}
```

# Step 2: Create a JAXP Document Builder

- **First create an instance of a builder factory, then use that to create a `DocumentBuilder` object**

```
DocumentBuilderFactory builderFactory =
  DocumentBuilderFactory.newInstance();
DocumentBuilder builder =
  builderFactory.newDocumentBuilder();
```

  - A builder is basically a wrapper around a specific XML parser
  - To set up namespace awareness and validation, use

```
builderFactory.setNamespaceAware(true)
builderFactory.setValidating(true)
```

# Step3: Invoke the Parser to Create a Document

- **Call the `parse` method of the `DocumentBuilder`, supplying an XML document (input stream)**

```
Document document = builder.parse(someInputStream);
```

  - The `Document` class represents the parsed result in a tree structure
  - The XML document can be represented as a:
    - URI, represented as a string
    - `InputStream`
    - `org.xml.sax.InputSource`

# Step 4: Normalize the Tree

- **Normalization has two affects:**
  - Combines textual nodes that span multiple lines
  - Eliminates empty textual nodes

```
document.getDocumentElement().normalize();
```

# Step 5: Obtain the Root Node of the Tree

- **Traversing and modifying the tree begins at the root node**

```
Element rootElement = document.getDocumentElement();
```

  - An `Element` is a subclass of the more general `Node` class and represents an XML element
  - A `Node` represents all the various components of an XML document
    - Document, Element, Attribute, Entity, Text, CDATA, Processing Instruction, Comment, etc.

# Step 6: Examine and Modify Properties of the Node

- **Examine the various `node` properties**
  - getNodeName
    - Returns the name of the element
  - getNodeType
    - Returns the node type
    - Compare to `Node` constants
      - `DOCUMENT_NODE`, `ELEMENT_NODE`, etc.
  - getAttributes
    - Returns a `NamedNodeMap` (collection of nodes, each representing an attribute)
      - Obtain particular attribute node through `getNamedItem`
  - getChildNodes
    - Returns a `NodeList` collection of all the children

# Step 6: Examine and Modify Properties of the Node (cont)

- **Modify the document**
  - setNodeValue
    - Assigns the text value of the node
  - appendChild
    - Adds a new node to the list of children
  - removeChild
    - Removes the child node from the list of children
  - replaceChild
    - Replace a child with a new node

# DOM Example: Representing an XML Document as a JTree

- **Approach**
  - Each XML document element is represented as a tree node (in the `JTree`)
  - Each tree node is either the element name or the element name followed by a list of attributes

# DOM Example: Representing an XML Document as a JTree

- **Approach (cont.)**
  - The following steps are performed:
    1. Parse and normalize the XML document and then obtain the root node
    2. Turn the root note into a `JTree` node
       - The element name (`getNodeName`) is used for the tree node label
       - If attributes are present (`node.getAttributes`), then include them in the label enclosed in parentheses
    3. Look up child elements (`getChildNodes`) and turn them into `JTree` nodes, linking to their parent tree node
    4. Recursively apply step 3 to all child nodes

# DOM Example: XMLTree

```
import java.awt.*;
import javax.swing.*;
import javax.swing.tree.*;
import java.io.*;
import org.w3c.dom.*;
import javax.xml.parsers.*;

/** Given a filename or a name and an input stream,
 *  this class generates a JTree representing the
 *  XML structure contained in the file or stream.
 *  Parses with DOM then copies the tree structure
 *  (minus text and comment nodes).
 */

public class XMLTree extends JTree {
  public XMLTree(String filename) throws IOException {
    this(filename, new FileInputStream(new File(filename)));
  }

  public XMLTree(String filename, InputStream in) {
    super(makeRootNode(in));
  }
```

# DOM Example: XMLTree (continued)

```
private static DefaultMutableTreeNode
                                    makeRootNode(InputStream in) {
  try {
    // Use the system property
    // javax.xml.parsers.DocumentBuilderFactory (set either
    // from Java code or by using the -D option to "java").
    DocumentBuilderFactory builderFactory =
      DocumentBuilderFactory.newInstance();
    DocumentBuilder builder =
      builderFactory.newDocumentBuilder();
    Document document = builder.parse(in);
    document.getDocumentElement().normalize();
    Element rootElement = document.getDocumentElement();
    DefaultMutableTreeNode rootTreeNode =
      buildTree(rootElement);
    return(rootTreeNode);
  } catch(Exception e) {
    String errorMessage = "Error making root node: " + e;
    System.err.println(errorMessage);
    e.printStackTrace();
    return(new DefaultMutableTreeNode(errorMessage));
  }
}
```

# DOM Example: XMLTree (continued)

```
...
private static DefaultMutableTreeNode
                                buildTree(Element rootElement) {

  // Make a JTree node for the root, then make JTree
  // nodes for each child and add them to the root node.
  // The addChildren method is recursive.

  DefaultMutableTreeNode rootTreeNode =
    new DefaultMutableTreeNode(treeNodeLabel(rootElement));
  addChildren(rootTreeNode, rootElement);
  return(rootTreeNode);
}
...
```

# DOM Example: XMLTree (continued)

```
private static void addChildren
    (DefaultMutableTreeNode parentTreeNode, Node parentXMLElement) {
    // Recursive method that finds all the child elements and adds
    // them to the parent node. Nodes corresponding to the graphical
    // JTree will have the word "tree" in the variable name.
    NodeList childElements =
      parentXMLElement.getChildNodes();
    for(int i=0; i<childElements.getLength(); i++) {
      Node childElement = childElements.item(i);
      if (!(childElement instanceof Text ||
            childElement instanceof Comment)) {
        DefaultMutableTreeNode childTreeNode =
          new DefaultMutableTreeNode
            (treeNodeLabel(childElement));
        parentTreeNode.add(childTreeNode);
        addChildren(childTreeNode, childElement);
      }
    }
  }
```

# DOM Example: XMLTree (continued)

```
...
private static String treeNodeLabel(Node childElement) {
  NamedNodeMap elementAttributes =
    childElement.getAttributes();
  String treeNodeLabel = childElement.getNodeName();
  if (elementAttributes != null &&
      elementAttributes.getLength() > 0) {
    treeNodeLabel = treeNodeLabel + " (";
    int numAttributes = elementAttributes.getLength();
    for(int i=0; i<numAttributes; i++) {
      Node attribute = elementAttributes.item(i);
      if (i > 0) {
        treeNodeLabel = treeNodeLabel + ", ";
      }
      treeNodeLabel =
        treeNodeLabel + attribute.getNodeName() +
        "=" + attribute.getNodeValue();
    }
    treeNodeLabel = treeNodeLabel + ")";
  }
  return(treeNodeLabel);
}
}
```

# DOM Example: XMLFrame

```
import java.awt.*;
import javax.swing.*;
import java.io.*;

public class XMLFrame extends JFrame {
  public static void main(String[] args) {
    String jaxpPropertyName =
      "javax.xml.parsers.DocumentBuilderFactory";
    // Pass the parser factory in on the command line with
    // -D to override the use of the Apache parser.
    if (System.getProperty(jaxpPropertyName) == null) {
      String apacheXercesPropertyValue =
        "org.apache.xerces.jaxp.DocumentBuilderFactoryImpl";
      System.setProperty(jaxpPropertyName,
                         apacheXercesPropertyValue);
    }
    ...
```

# DOM Example: XMLFrame (continued)

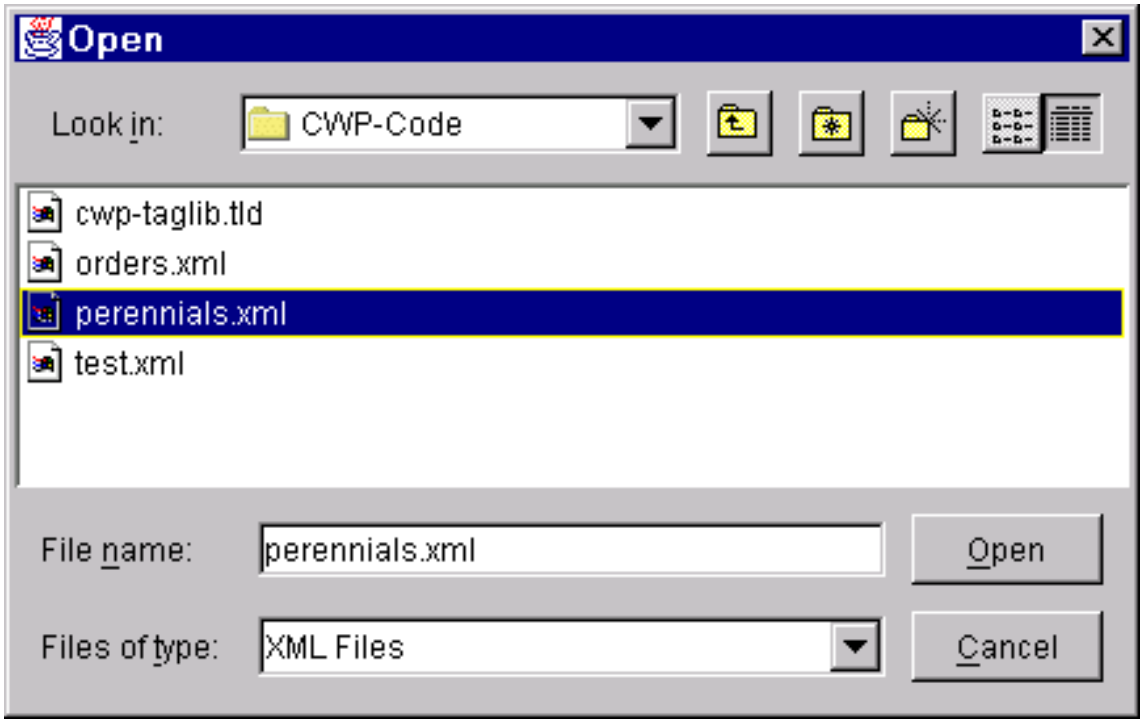
```
    String[] extensions = { "xml", "tld" };
    WindowUtilities.setNativeLookAndFeel();
    String filename = ExtensionFileFilter.getFileName(".",
                                "XML Files", extensions);
    new XMLFrame(filename);
  }

  public XMLFrame(String filename) {
    try {
      WindowUtilities.setNativeLookAndFeel();
      JTree tree = new XMLTree(filename);
      JFrame frame = new JFrame(filename);
      frame.addWindowListener(new ExitListener());
      Container content = frame.getContentPane();
      content.add(new JScrollPane(tree));
      frame.pack();
      frame.setVisible(true);
    } catch(IOException ioe) {
      System.out.println("Error creating tree: " + ioe);
    }
  }
}
```

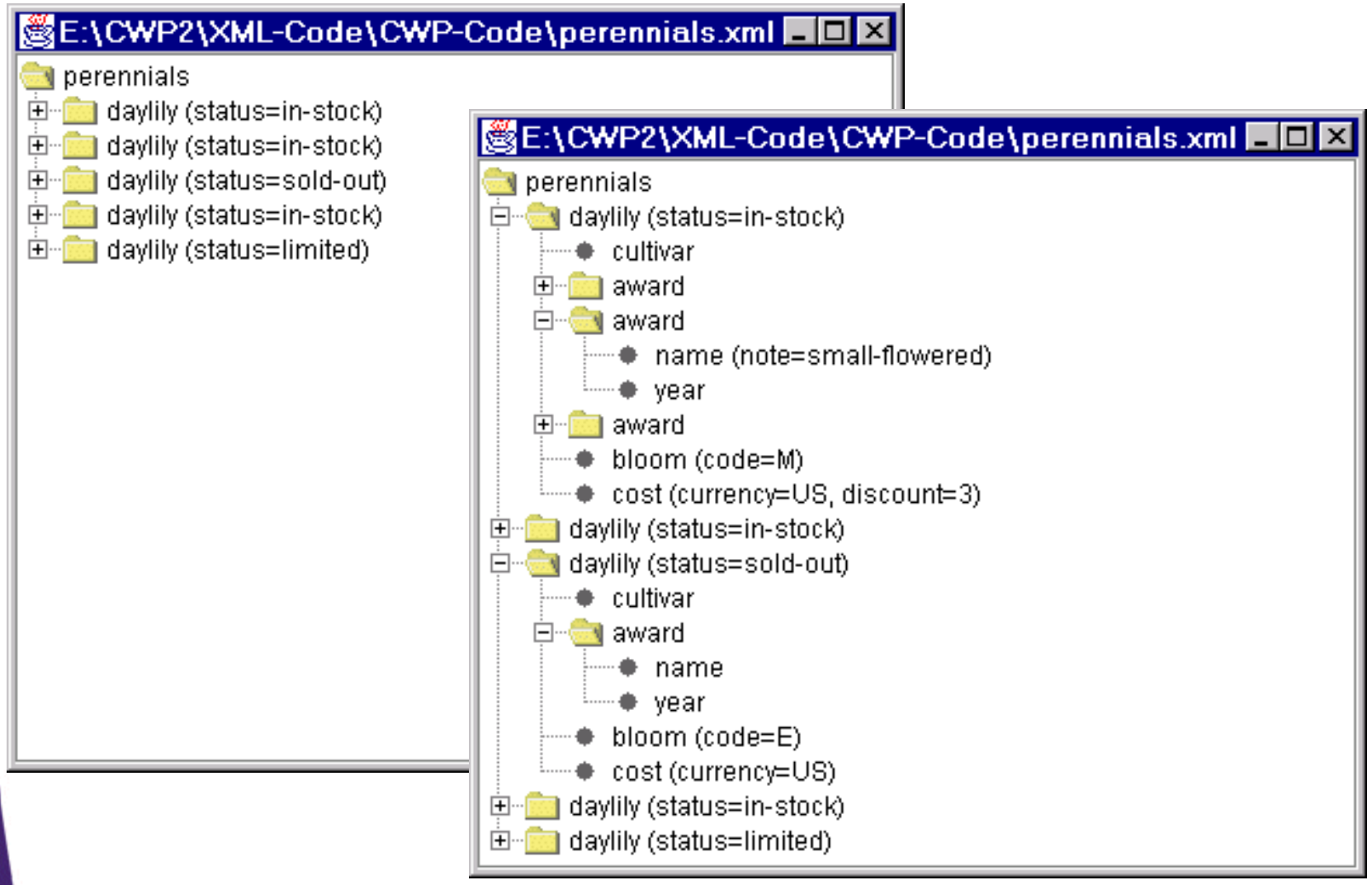
# DOM Example: perennials.xml

```
<?xml version="1.0"?>
<!DOCTYPE perennials SYSTEM "dtds/perennials.dtd">
<perennials>
  <daylily status="in-stock">
    <cultivar>Luxury Lace</cultivar>
    <award>
      <name>Stout Medal</name>
      <year>1965</year>
    </award>
    <award>
      <name note="small-flowered">Annie T. Giles</name>
      <year>1965</year>
    </award>
    <award>
      <name>Lenington All-American</name>
      <year>1970</year>
    </award>
    <bloom code="M">Midseason</bloom>
    <cost discount="3" currency="US">11.75</cost>
  </daylily>
  ...
<perennials>
```

# DOM Example: Results



# DOM Example: Results (continued)



# DOM or SAX?

- **DOM**
  - Suitable for small documents
  - Easily modify document
  - Memory intensive; load the complete XML document
- **SAX**
  - Suitable for large documents; saves significant amounts of memory
  - Only traverse document once, start to end
  - Event driven
  - Limited standard functions

# Summary

- **DOM is a tree representation of an XML document in memory**
  - DOM provides a robust API to easily modify and extract data from an XML document
- **JAXP provides a vendor-neutral interface to the underlying DOM or SAX parser**
- **Every component of the XML document is represent as a Node**
- **Use normalization to combine text elements spanning multiple lines**

# Simple API for XML

- **Introduction to SAX**
- **Installation and setup**
- **Steps for SAX parsing**
- **Defining a content handler**
- **Examples**
  - Printing the Outline of an XML Document
  - Counting Book Orders
- **Defining an error handler**
- **Validating a document**

# Simple API for XML (SAX)

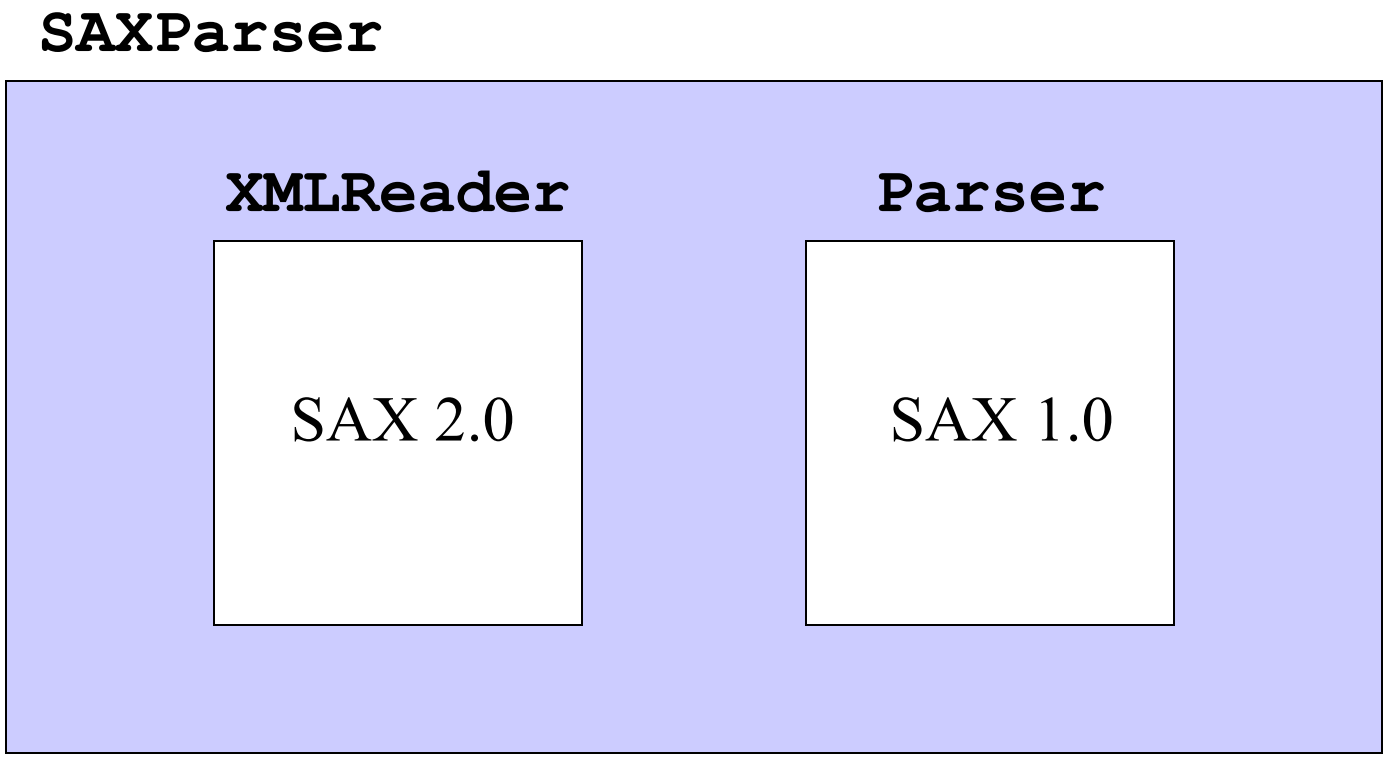
- **Parse and process XML documents**
- **Documents are read sequentially and callbacks are made to handlers**
- **Event-driven model for processing XML content**
- **SAX Versions**
  - SAX 1.0 (May 1998)
  - SAX 2.0 (May 2000)
    - Namespace addition
  - Official Website for SAX
    - `http://sax.sourceforge.net/`

# SAX Advantages and Disadvantages

- **Advantages**
  - Do not need to process and store the entire document (low memory requirement)
    - Can quickly skip over parts not of interest
  - Fast processing
- **Disadvantages**
  - Limited API
    - Every element is processed through the same event handler
    - Need to keep track of location in document and, in cases, store temporary data
  - Only traverse the document once

# Java API for XML Parsing (JAXP)

- **JAXP provides a vendor-neutral interface to the underlying SAX 1.0/2.0 parser**



# SAX Installation and Setup

1. **Download a SAX 2-compliant parser**
   - Java-based XML parsers at `http://www.xml.com/pub/rg/Java_Parsers`
   - Recommend Apache Xerces-J parser at `http://xml.apache.org/xerces-j/`
2. **Download the Java API for XML Processing (JAXP)**
   - JAXP is a small layer on top of SAX which supports specifying parsers through system properties versus hard coded
   - See `http://java.sun.com/xml/`
   - Note: Apache Xerces-J already incorporates JAXP

# SAX Installation and Setup (continued)

## 3. Set your `CLASSPATH` to include the SAX (and JAXP) classes

```
set CLASSPATH=xerces_install_dir\xerces.jar;
              %CLASSPATH%
```

or

```
setenv CLASSPATH xerces_install_dir/xerces.jar:
                 $CLASSPATH
```

- For servlets, place `xerces.jar` in the server's `lib` directory
  - Note: Tomcat 4.0 is prebundled with `xerces.jar`
- Xerces-J already incorporates JAXP
  - For other parsers you may need to add `jaxp.jar` to your classpath and servlet `lib` directory

# Aside: Using Xerces with Tomcat 3.2.x

- **Problem**
  - Tomcat 3.2.x may load the provided SAX 1.0 parser first (`parser.jar`) before `xerces.jar`, effectively eliminating namespace support required in SAX 2.0

- **Solutions**
  1. Set up a static `CLASSPATH` and place `xerces.jar` *first* in the list
  2. As the files are loaded alphabetically, rename `parser.jar` to `z_parser.jar` and `xml.jar` to `z_xml.jar`

# SAX Parsing

- **SAX parsing has two high-level tasks:**

1. Creating a content handler to process the XML elements when they are encountered
2. Invoking a parser with the designated content handler and document

# Steps for SAX Parsing

1. Tell the system which parser you want to use
2. Create a parser instance
3. Create a content handler to respond to parsing events
4. Invoke the parser with the designated content handler and document

# Step 1: Specifying a Parser

- **Approaches to specify a parser**
  - Set a system property for `javax.xml.parsers.SAXParserFactory`
  - Specify the parser in `jre_dir/lib/jaxp.properties`
  - Through the J2EE Services API and the class specified in `META-INF/services/javax.xml.parsers.SAXParserFactory`
  - Use system-dependant default parser (check documentation)

# Specifying a Parser, Example

- **The following example:**
  - Permits the user to specify the parser through the command line `-D` option

```
java -Djavax.xml.parser.SAXParserFactory=
     com.sun.xml.parser.SAXParserFactoryImpl ...
```

  - Uses the Apache Xerces parser otherwise

```
public static void main(String[] args) {
  String jaxpPropertyName =
    "javax.xml.parsers.SAXParserFactory";
  if (System.getProperty(jaxpPropertyName) == null) {
    String apacheXercesPropertyValue =
      "org.apache.xerces.jaxp.SAXParserFactoryImpl";
    System.setProperty(jaxpPropertyName,
                       apacheXercesPropertyValue);
  }
  ...
}
```

# Step 2: Creating a Parser Instance

- **First create an instance of a parser factory, then use that to create a `SAXParser` object**

```
SAXParserFactory factory =
  SAXParserFactory.newInstance();
SAXParser parser = factory.newSAXParser();
```

  - To set up namespace awareness and validation, use

```
factory.setNamespaceAware(true)
factory.setValidating(true)
```

# Step 3: Create a Content Handler

- **Content handler responds to parsing events**
  - Typically a subclass of `DefaultHandler`

```
public class MyHandler extends DefaultHandler {
  // Callback methods
  ...
}
```

- **Primary event methods (callbacks)**
  - startDocument, endDocument
    - Respond to the start and end of the document
  - startElement, endElement
    - Respond to the start and end tags of an element
  - characters, ignoreableWhitespace
    - Respond to the tag body

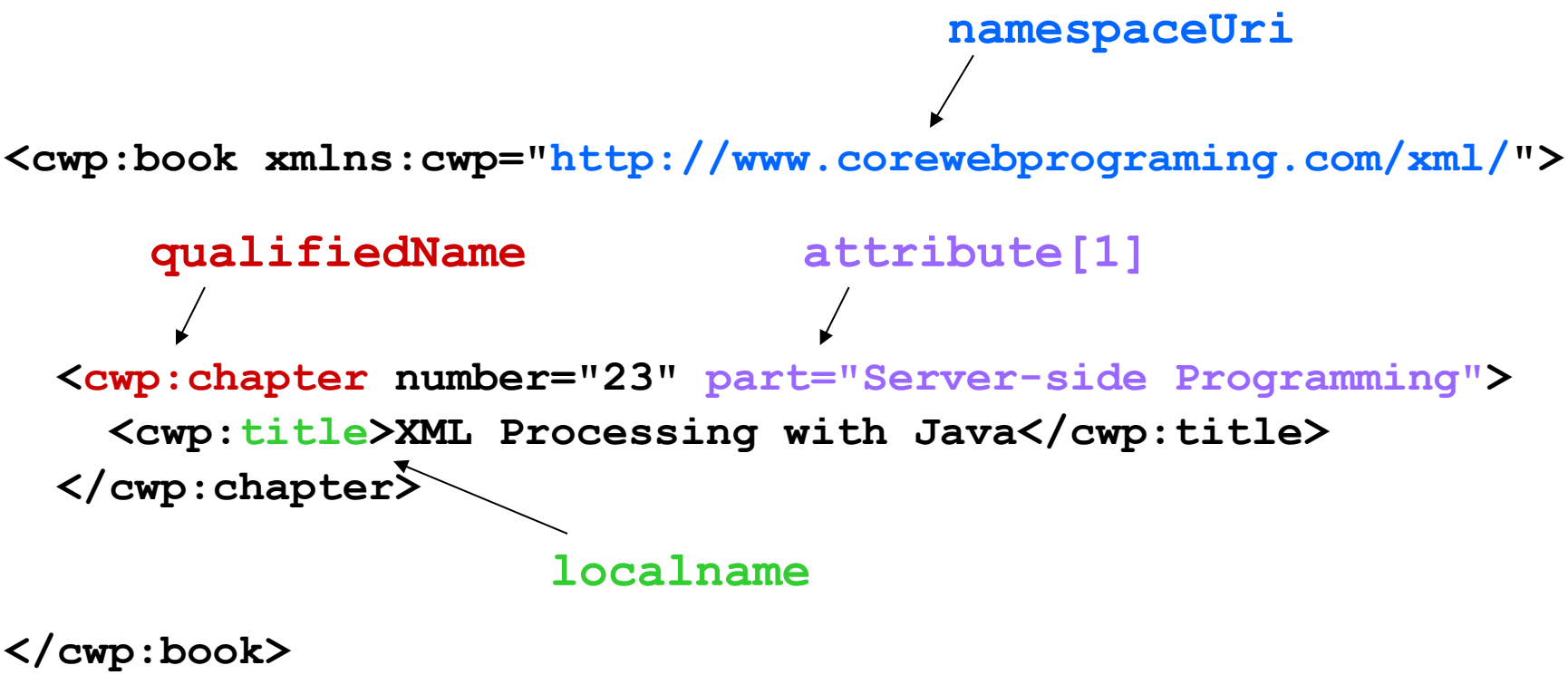
# ContentHandler startElement Method

- **Declaration**

```
public void startElement(String nameSpaceURI,
                         String localName,
                         String qualifiedName,
                         Attributes attributes)
                  throws SAXException
```

- **Arguments**
  - namespaceUri
    - URI uniquely identifying the namespace
  - localname
    - Element name without prefix
  - qualifiedName
    - Complete element name, including prefix
  - attributes
    - `Attributes` object representing the attributes of the element

# Anatomy of an Element



# ContentHandler characters Method

- **Declaration**

```
public void characters(char[] chars,
                       int startIndex,
                       int length)
                throws SAXException
```

- **Arguments**
  - chars
    - Relevant characters form XML document
    - To optimize parsers, the chars array may represent more of the XML document than just the element
    - **PCDATA** may cause multiple invocations of characters
  - startIndex
    - Starting position of element
  - length
    - The number of characters to extract

# Step 4: Invoke the Parser

- **Call the parse method, supplying:**
  1. The content handler
  2. The XML document
     - File, input stream, or `org.xml.sax.InputSource`

```
parser.parse(filename, handler)
```

# SAX Example 1: Printing the Outline of an XML Document

- **Approach**
  - Define a content handler to respond to three parts of an XML document: start tags, end tag, and tag bodies
  - Content handler implementation overrides the following three methods:
    - startElement
      - Prints a message when start tag is found with attributes listed in parentheses
      - Adjusts (increases by 2 spaces) the indentation
    - endElement
      - Subtracts 2 from the indentation and prints a message indicating that an end tag was found
    - characters
      - Prints the first word of the tag body

# SAX Example 1: PrintHandler

```
import org.xml.sax.*;
import org.xml.sax.helpers.*;
import java.util.StringTokenizer;

public class PrintHandler extends DefaultHandler {
  private int indentation = 0;

  /** When you see a start tag, print it out and then
   *  increase indentation by two spaces. If the
   *  element has attributes, place them in parens
   *  after the element name.
   */
  public void startElement(String namespaceUri,
                           String localName,
                           String qualifiedName,
                           Attributes attributes)
      throws SAXException {
    indent(indentation);
    System.out.print("Start tag: " + qualifiedName);
```

# SAX Example 1: PrintHandler (continued)

```
  ...
  int numAttributes = attributes.getLength();
  // For <someTag> just print out "someTag". But for
  // <someTag att1="Val1" att2="Val2">, print out
  // "someTag (att1=Val1, att2=Val2).
  if (numAttributes > 0) {
    System.out.print(" (");
    for(int i=0; i<numAttributes; i++) {
      if (i>0) {
        System.out.print(", ");
      }
      System.out.print(attributes.getQName(i) + "=" +
                       attributes.getValue(i));
    }
    System.out.print(")");
  }
  System.out.println();
  indentation = indentation + 2;
}
...
```

# SAX Example 1: PrintHandler (continued)

```
/** When you see the end tag, print it out and decrease
 *  indentation level by 2.
 */

public void endElement(String namespaceUri,
                       String localName,
                       String qualifiedName)
    throws SAXException {
  indentation = indentation - 2;
  indent(indentation);
  System.out.println("End tag: " + qualifiedName);
}

private void indent(int indentation) {
  for(int i=0; i<indentation; i++) {
    System.out.print(" ");
  }
}
...
```

# SAX Example 1: PrintHandler (continued)

```
  /** Print out the first word of each tag body. */

  public void characters(char[] chars,
                         int startIndex,
                         int length) {
    String data = new String(chars, startIndex, length);
    // Whitespace makes up default StringTokenizer delimeters
    StringTokenizer tok = new StringTokenizer(data);
    if (tok.hasMoreTokens()) {
      indent(indentation);
      System.out.print(tok.nextToken());
      if (tok.hasMoreTokens()) {
        System.out.println("...");
      } else {
        System.out.println();
      }
    }
  }
}
```

# SAX Example 1: SAXPrinter

```
import javax.xml.parsers.*;
import org.xml.sax.*;
import org.xml.sax.helpers.*;

public class SAXPrinter {
  public static void main(String[] args) {
    String jaxpPropertyName =
      "javax.xml.parsers.SAXParserFactory";
    // Pass the parser factory in on the command line with
    // -D to override the use of the Apache parser.
    if (System.getProperty(jaxpPropertyName) == null) {
      String apacheXercesPropertyValue =
        "org.apache.xerces.jaxp.SAXParserFactoryImpl";
      System.setProperty(jaxpPropertyName,
                         apacheXercesPropertyValue);
    }
```

# SAX Example 1: SAXPrinter (continued)

```
    ...
    String filename;
    if (args.length > 0) {
      filename = args[0];
    } else {
      String[] extensions = { "xml", "tld" };
      WindowUtilities.setNativeLookAndFeel();
      filename =
        ExtensionFileFilter.getFileName(".", "XML Files",
                                        extensions);
      if (filename == null) {
        filename = "test.xml";
      }
    }
    printOutline(filename);
    System.exit(0);
  }
  ...
```

# SAX Example 1: SAXPrinter (continued)

```
  ...
  public static void printOutline(String filename) {
    DefaultHandler handler = new PrintHandler();
    SAXParserFactory factory =
       SAXParserFactory.newInstance();
    try {
      SAXParser parser = factory.newSAXParser();
      parser.parse(filename, handler);
    } catch(Exception e) {
      String errorMessage =
        "Error parsing " + filename + ": " + e;
      System.err.println(errorMessage);
      e.printStackTrace();
    }
  }
}
```

# SAX Example 1: orders.xml

```
<?xml version="1.0"?>
<orders>
  <order>
    <count>1</count>
    <price>9.95</price>
    <yacht>
      <manufacturer>Luxury Yachts, Inc.</manufacturer>
      <model>M-1</model>
      <standardFeatures oars="plastic"
                        lifeVests="none">
        false
      </standardFeatures>
    </yacht>
  </order>
  ...
</orders>
```

# SAX Example 1: Result

```
Start tag: orders
  Start tag: order
    Start tag: count
      1
    End tag: count
    Start tag: price
      9.95
    End tag: price
    Start tag: yacht
      Start tag: manufacturer
        Luxury...
      End tag: manufacturer
      Start tag: model
        M-1
      End tag: model
      Start tag: standardFeatures (oars=plastic, lifeVests=none)
        false
      End tag: standardFeatures
    End tag: yacht
  End tag: order
  ...
End tag: orders
```

# SAX Example 2: Counting Book Orders

- **Objective**
  - To process XML files that look like:

```
<orders>
  ...
  <count>23</count>
  <book>
    <isbn>013897930</isbn>
    ...
  </book>
  ...
</orders>
```

and count up how many copies of Core Web Programming (ISBN 013897930) are contained in the order

# SAX Example 2: Counting Book Orders (continued)

- **Problem**
  - SAX doesn't store data automatically
  - The `isbn` element comes after the `count` element
  - Need to record every count temporarily, but only add the temporary value (to the running total) when the ISBN number matches

# SAX Example 2: Approach

- **Define a content handler to override the following four methods:**
  - startElement
    - Checks whether the name of the element is either `count` or `isbn`
    - Set flag to tell `characters` method be on the lookout
  - endElement
    - Again, checks whether the name of the element is either `count` or `isbn`
    - If so, turns off the flag that the `characters` method watches

# SAX Example 2: Approach (continued)

- characters
  - Subtracts 2 from the indentation and prints a message indicating that an end tag was found
- endDocument
  - Prints out the running count in a Message Dialog

# SAX Example 2: CountHandler

```
import org.xml.sax.*;
import org.xml.sax.helpers.*;
...

public class CountHandler extends DefaultHandler {
  private boolean collectCount = false;
  private boolean collectISBN = false;
  private int currentCount = 0;
  private int totalCount = 0;

  public void startElement(String namespaceUri,
                           String localName,
                           String qualifiedName,
                           Attributes attributes)
      throws SAXException {
    if (qualifiedName.equals("count")) {
      collectCount = true;
      currentCount = 0;
    } else if (qualifiedName.equals("isbn")) {
      collectISBN = true;
    }
  }
  ...
```

# SAX Example 2: CountHandler (continued)

```
...
public void endElement(String namespaceUri,
                       String localName,
                       String qualifiedName)
    throws SAXException {
  if (qualifiedName.equals("count")) {
    collectCount = false;
  } else if (qualifiedName.equals("isbn")) {
    collectISBN = false;
  }
}

public void endDocument() throws SAXException {
  String message =
    "You ordered " + totalCount + " copies of \n" +
    "Core Web Programming Second Edition.\n";
  if (totalCount < 250) {
    message = message + "Please order more next time!";
  } else {
    message = message + "Thanks for your order.";
  }
  JOptionPane.showMessageDialog(null, message);
}
```

# SAX Example 2: CountHandler (continued)

```
...
public void characters(char[] chars, int startIndex,
                       int length) {
 if (collectCount || collectISBN) {
   String dataString =
     new String(chars, startIndex, length).trim();
   if (collectCount) {
     try {
       currentCount = Integer.parseInt(dataString);
     } catch(NumberFormatException nfe) {
       System.err.println("Ignoring malformed count: " +
                          dataString);
     }
   } else if (collectISBN) {
     if (dataString.equals("0130897930")) {
       totalCount = totalCount + currentCount;
     }
   }
 }
}
```

# SAX Example 2: CountBooks

```
import javax.xml.parsers.*;
import org.xml.sax.*;
import org.xml.sax.helpers.*;

public class CountBooks {
  public static void main(String[] args) {
    String jaxpPropertyName = "javax.xml.parsers.SAXParserFactory";
    // Use -D to override the use of the Apache parser.
    if (System.getProperty(jaxpPropertyName) == null) {
      String apacheXercesPropertyValue =
        "org.apache.xerces.jaxp.SAXParserFactoryImpl";
      System.setProperty(jaxpPropertyName,
                         apacheXercesPropertyValue);
    }
    String filename;
    if (args.length > 0) {
      filename = args[0];
    } else {
      ...
    }
    countBooks(filename);
    System.exit(0);
  }
```

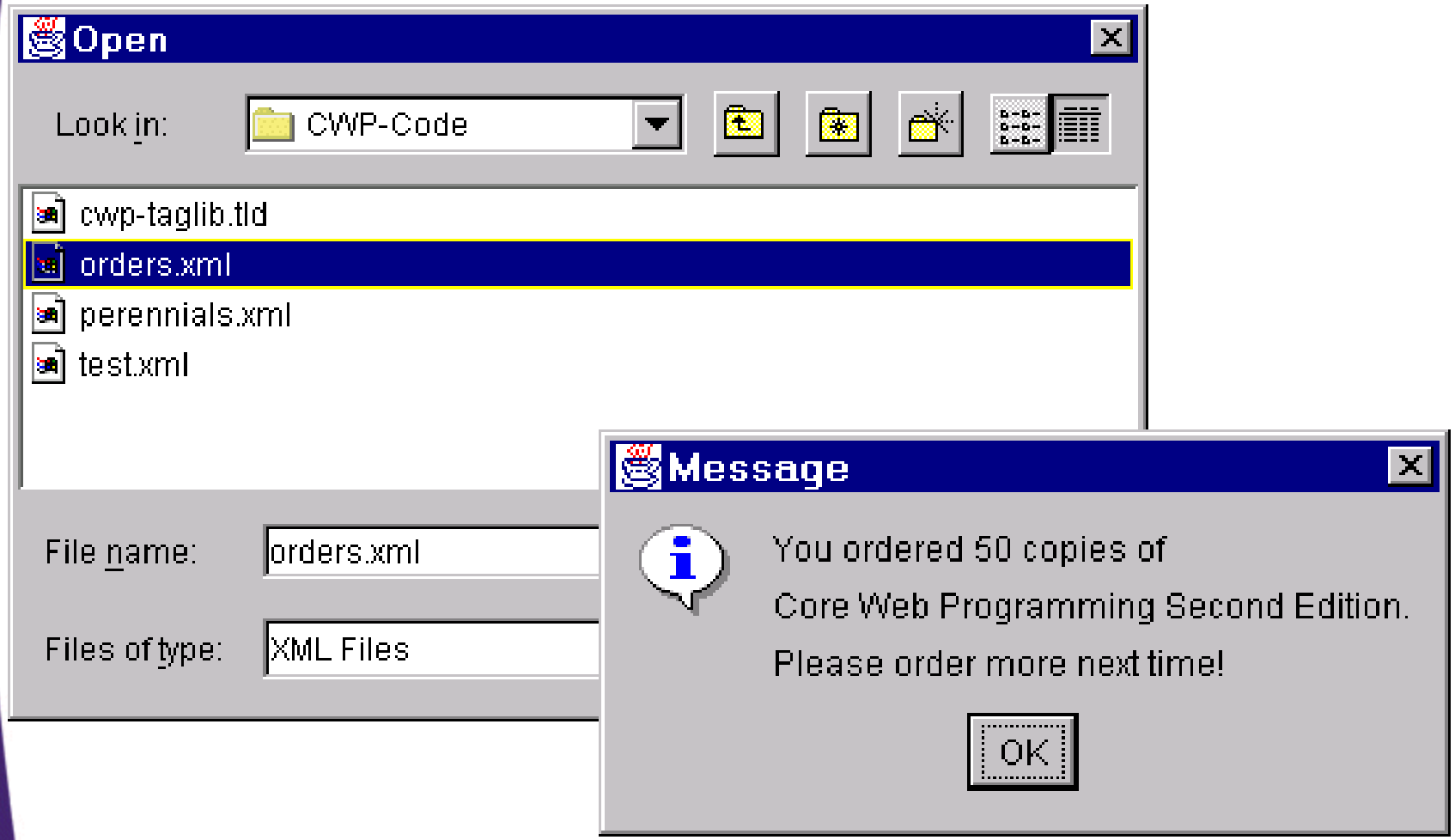
# SAX Example 2: CountBooks (continued)

```
  private static void countBooks(String filename) {
    DefaultHandler handler = new CountHandler();
    SAXParserFactory factory =
      SAXParserFactory.newInstance();
    try {
      SAXParser parser = factory.newSAXParser();
      parser.parse(filename, handler);
    } catch(Exception e) {
      String errorMessage =
        "Error parsing " + filename + ": " + e;
      System.err.println(errorMessage);
      e.printStackTrace();
    }
  }
}
```

# SAX Example 2: orders.xml

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

# SAX Example 2: Result



# Error Handlers

- Responds to parsing errors
  - Typically a subclass of `DefaultErrorHandler`
- Useful callback methods
  - error
    - Nonfatal error
    - Usual a result of document validity problems
  - fatalError
    - A fatal error resulting from a malformed document
  - Receive a `SAXParseException` from which to obtain the location of the problem (`getColumnNumber`, `getLineNumber`)

# Error Handler Example

```
import org.xml.sax.*;
import org.apache.xml.utils.*;

class MyErrorHandler extends DefaultErrorHandler  {

  public void error(SAXParseException exception)
    throws SAXException {

    System.out.println(
      "**Parsing Error**\n" +
      "  Line:    " + exception.getLineNumber() + "\n" +
      "  URI:     " + exception.getSystemId() + "\n" +
      "  Message: " + exception.getMessage() + "\n");
    throw new SAXException("Error encountered");
  }
}
```

# Namespace Awareness and Validation

- **Approaches**
  1. Through the SAXParserFactory

```
factory.setNamespaceAware(true)
factory.setValidating(true)
SAXParser parser = factory.newSAXParser();
```

  2. By setting XMLReader features

```
XMLReader reader = parser.getXMLReader();
reader.setFeature(
  "http://xml.org/sax/features/validation", true);
reader.setFeature(
  "http://xml.org/sax/features/namespaces", false);
```

     - Note: a `SAXParser` is a vendor-neutral wrapper around a SAX 2 `XMLReader`

# Validation Example

```
public class SAXValidator {
  public static void main(String[] args) {
    String jaxpPropertyName =
 "javax.xml.parsers.SAXParserFactory";
    // Use -D to override the use of the Apache parser.
    if (System.getProperty(jaxpPropertyName) == null) {
      String apacheXercesPropertyValue =
        "org.apache.xerces.jaxp.SAXParserFactoryImpl";
      System.setProperty(jaxpPropertyName,
                         apacheXercesPropertyValue);
    }
    String filename;
    if (args.length > 0) {
      filename = args[0];
    } else {
      ...
    }
    validate(filename);
    System.exit(0);
  }
```

# Validation Example (continued)

```
...
public static void validate(String filename) {
  DefaultHandler contentHandler = new DefaultHandler();
  ErrorHandler errHandler = new MyErrorHandler();
  SAXParserFactory factory =
    SAXParserFactory.newInstance();
  factory.setValidating(true);
  try {
    SAXParser parser = factory.newSAXParser();
    XMLReader reader = parser.getXMLReader();
    reader.setContentHandler(contentHandler);
    reader.setErrorHandler(errHandler);
    reader.parse(new InputSource(filename));
  } catch(Exception e) {
    String errorMessage =
      "Error parsing " + filename;
    System.out.println(errorMessage);
  }
 }
}
```

# Instructors.xml

```
<?xml version="1.0" standalone="yes"?>
<!DOCTYPE jhu [
<!ELEMENT jhu (instructor)*>
<!ELEMENT instructor (firstname, lastname)+>
<!ELEMENT firstname (#PCDATA)>
<!ELEMENT lastname (#PCDATA)>
]>
<jhu>
  <instructor>
    <firstname>Larry</firstname>
    <lastname>Brown</lastname>
  </instructor>
  <instructor>
    <lastname>Hall</lastname>
    <firstname>Marty</firstname>
  </instructor>
</jhu>
```

# Validation Results

```
>java SAXValidator

Parsing Error:
  Line: 16
  URI:  file:///C:/CWP2-Book/chapter23/Instructors.xml
  Message: The content of element type "instructor"
           must match "(firstname,lastname)+".

Error parsing C:\CWP2-Book\chapter23\Instructors.xml
```

# Summary

- **SAX processing of XML documents is fast and memory efficient**
- **JAXP is a simple API to provide vendor neutral SAX parsing**
  - Parser is specified through system properties
- **Processing is achieved through event call backs**
  - Parser communicates with a DocumentHandler
  - May require tracking the location in document and storing data in temporary variables
- **Parsing properties (validation, namespace awareness) are set through the SAXParser or underlying XMLReader**

# XLST Processing with Java

- **XSLT Overview**
- **Understanding XPath notation**
- **Processing elements in XSLT templates**
- **XSLT installation and setup**
- **An XSL Transformer**
- **Example:**
  - Document Editor
  - XSLT custom tag

# Extensible Stylesheet Language Transformations

- **XSLT applies user-defined transformations to an XML document**
  - Transformed output can be:
    - HTML, XML, WML, etc.
- **XSLT Versions**
  - XSLT 1.0 (Nov 1999)
  - XSLT 2.0 (requirements, Feb 2001)
    - Namespace addition
  - Official Website for XSLT
    - `http://www.w3.org/Style/XSL/`

# Extensible Stylesheet Language (XSL)

- **XSL is a language for expressing stylesheets**
  - XSLT
    - Transformation of XML document
    - `http://www.w3.org/TR/xslt`
  - XPath
    - An expression language used by XSLT to locate elements and/or attributes within an XML document
    - `http://www.w3.org/TR/xpath`
  - XSL-FO (Formatting Objects)
    - Specifies the formatting properties for rendering the document
    - `http://www.w3.org/TR/XSL/XSL-FO/`

# XSLT Advantages and Disadvantages

- **Advantages**
  - Easy to merge XML data into a presentation
  - More resilient to changes in the details of the XML documents than low-level DOM and SAX
  - Database queries can be retuned in XML
    - Insensitive to column order
- **Disadvantages**
  - Memory intensive and suffers a performance penalty
  - Difficult to implement complicated business rules
  - Have to learn a new language
  - Can't change the value of variables (requires recursion)

# XSLT Parsers

- **Apache Xalan**
  - http://xml.apache.org/xalan/
- **Oracle**
  - http://technet.oracle.com/tech/xml/
- **Saxon**
  - http://saxon.sourceforge.net/
  - Written by Michael Kay
- **Microsoft's XML Parser 4.0 (MSXML)**
  - http://www.microsoft.com/xml/

# XSLT Installation and Setup

1. **Download a XSLT compliant parser**
   - XSLT parsers at `http://www.xmlsoftware.com/xslt/`
   - Recommend Apache Xalan-J 2.3 parser at `http://xml.apache.org/xalan-j/`
2. **Download a SAX 2-compliant parser**
   - Java-based XML parsers at `http://www.xml.com/pub/rg/Java_Parsers`
   - Recommend Apache Xerces-J parser at `http://xml.apache.org/xerces-j/`
   - Note that `xerces.jar` is bundled with the Xalan-J download and is also prebundled with Tomcat 4.0

# XSLT Installation and Setup (continued)

## 3. Download the Java API for XML Processing (JAXP)

- JAXP provides TrAX, a small layer on top of SAX and DOM which supports specifying transformers through system properties versus hard coded values
- See `http://java.sun.com/xml/`
- Note that TrAX is incorporated in Xalan-J

## 4. Bookmark the Java XSLT API

- Xalan-Java API is located at `http://xml.apache.org/xalan-j/apidocs/index.html`

# XSLT Installation and Setup (continued)

## 5. Set your `CLASSPATH` to include the XSLT and XML parser classes

```
set CLASSPATH=xalan_install_dir\xalan.jar;
  xalan_install_dir\xerces.jar;%CLASSPATH%
```

or

```
setenv CLASSPATH xalan_install_dir/xalan.jar:
  xalan_install_dir/xerces.jar:$CLASSPATH
```

- For servlets, place `xalan.jar` and `xerces.jar` in the server's `lib` directory
- Note that `xerces.jar` is the parser used by Tomcat 4.0 and is already located at (`$CATALINA_HOME/common/lib/`)

# Aside: Using Xerces with Tomcat 3.2.x

- **Problem**
  - Tomcat 3.2.x may load the provided DOM Level 1 parser first (`parser.jar`) from the TOMCAT_HOME/lib directory before `xerces.jar`, effectively eliminating SAX 2 and DOM Level 2 support (namespaces)

- **Solutions**
  1. Set up a static `CLASSPATH` and place `xalan.jar` and `xerces.jar` *first* in the list
  2. As the files are loaded alphabetically, rename `parser.jar` to `z_parser.jar` and `xml.jar` to `z_xml.jar`

# XSL Transformations

- **Use**
  - XPath to identify (select) parts of an XML document
  - XSLT templates to apply transformations
- **Requires**
  - Well formed XML document
  - XSL document (style sheet) that contains formatting and transformation templates
  - XSLT parser to perform the transformation

# Simple XSLT Example

- **The following example illustrates transforming an XML document into an HMTL TABLE**
  - Input
    - Style sheet (XSL): **`table.xsl`**
    - XML document: **`acronym.xml`**
  - Output
    - HTML document: **`acronym.html`**

# XSLT Stylesheet: table.xsl

```
<?xml version="1.0"?>
<xsl:stylesheet version="1.0"
  xmlns:xsl="http://www.w3.org/1999/XSL/Transform">
  <xsl:output method="html" />
  <xsl:template match="/">
    <TABLE CELLPADDING="3" BORDER="1" ALIGN="CENTER">
      <!-- Build table header, by selecting the
           name of each element in the first ROW.  -->
      <TR><TH></TH>
          <xsl:for-each select="ROWSET/ROW[1]/*">
            <TH><xsl:value-of select="name()" /></TH>
          </xsl:for-each>
      </TR>
      <!-- Apply template to build table rows -->
      <xsl:apply-templates select="ROWSET" />
    </TABLE>
  </xsl:template>
  ...
```

# XSLT Stylesheet: table.xsl (continues)

```
  ...

  <xsl:template match="ROW">
    <TR><TD><xsl:number /></TD>
            <!-- Select all elements in the ROW.
                 Populate each TD with the corresponding
                 text value of the element.
                 Note:    produces   by Xalan  -->
            <xsl:for-each select="*">
               <TD><xsl:value-of select="." /> </TD>
            </xsl:for-each>
    </TR>
  </xsl:template>
</xsl:stylesheet>
```

# XML Document: acronyms.xml

```
<?xml version="1.0"?>
<ROWSET>
  <ROW>
    <ACRONYM>DOM</ACRONYM>
    <DESCRIPTION>Document Object Model</DESCRIPTION>
  </ROW>
  <ROW>
    <ACRONYM>JAXP</ACRONYM>
    <DESCRIPTION>Java AIP for XML Parsing</DESCRIPTION>
  </ROW>
  <ROW>
    <ACRONYM>SAX</ACRONYM>
    <DESCRIPTION>Simple API for XML</DESCRIPTION>
  </ROW>
  <ROW>
    <ACRONYM>TrAX</ACRONYM>
    <DESCRIPTION>Transformation API for XML</DESCRIPTION>
  </ROW>
  <ROW>
    <ACRONYM>XSLT</ACRONYM>
    <DESCRIPTION>XSL Transformation</DESCRIPTION>
  </ROW>
</ROWSET>
```

# Transforming the XML Document

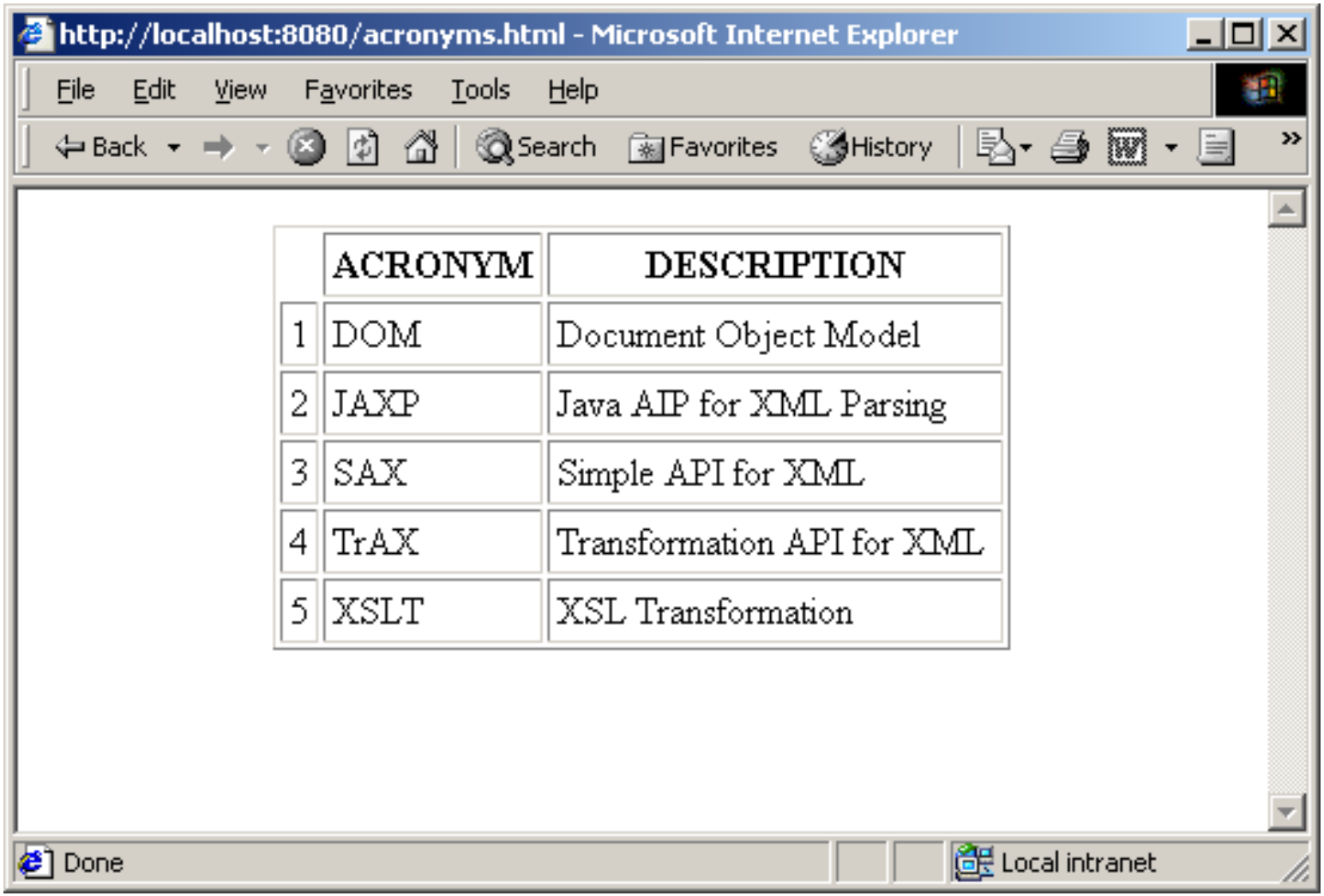
- **Use Xalan command-line interface**

```
> java org.apache.xalan.xslt.Process
        -in acronyms.xml
        -xsl table.xsl
        -out acronyms.html
```

# Transformation Result

```
<TABLE ALIGN="CENTER" BORDER="1" CELLPADDING="3">
<TR>
<TH></TH><TH>ACRONYM</TH><TH>DESCRIPTION</TH>
</TR>
<TR>
<TD>1</TD><TD>DOM </TD><TD>Document Object Model </TD>
</TR>
<TR>
<TD>2</TD><TD>JAXP </TD><TD>Java AIP for XML Parsing </TD>
</TR>
<TR>
<TD>3</TD><TD>SAX </TD><TD>Simple API for XML </TD>
</TR>
<TR>
<TD>4</TD><TD>TrAX </TD><TD>Transformation API for
   XML </TD>
</TR>
<TR>
<TD>5</TD><TD>XSLT </TD><TD>XSL Transformation </TD>
</TR>
</TABLE>
```

# Transformation Result (continued)




| | ACRONYM | DESCRIPTION |
|---|---|---|
| 1 | DOM | Document Object Model |
| 2 | JAXP | Java AIP for XML Parsing |
| 3 | SAX | Simple API for XML |
| 4 | TrAX | Transformation API for XML |
| 5 | XSLT | XSL Transformation |

# Understanding XPath

- **XPath is an *expression language* to:**
  - Identify parts (location paths) of the input document
    - Commonly used in **`match`** and **`select`** attributes in XSLT elements

```
<xsl:template match="/name/first" >
  ...
</xsl:template>
```

  - Test boolean conditions
  - Manipulate strings
  - Perform numerical calculations

# Location Paths

- **Location paths are interpreted with respect to a context**
  - Or simply, the node in the tree from which the expression is evaluated
- **The evaluated expression represents a set of nodes matching the condition**
  - Possibly the empty set if no matches occur
- **A location path consists of one or more location steps separated by / or //**
- **Paths can be relative or absolute**

# Simple Location Paths

- **Matching the root node**
  - A leading / indicates the root node

```
<xsl:template match="/" >
  <!-- Matches the root node.      -->
</xsl:template>
```

- **Matching all children**
  - Use the * wildcard to select all element nodes in the current context

```
<xsl:template match="*" >
  <!-- Matches all children nodes. -->
</xsl:template>
```

# Simple Location Paths (continued)

- **Matching an element**
  - Use / to separate elements when referring to a child
  - Use // to indicate that zero or more elements may occur between the slashes

```
<xsl:template match="/catalog/*/manufacturer" >
   <!--  Match all manufacturer elements    -->
   <!--  that are a grandchild of catalog.  -->
</xsl:template>

<xsl:template match="order//item" >
   <!--  Match all item elements that are   -->
   <!--  descendants of order.               -->
</xsl:template
```

# Matching with Predicates

- **Matching a specific element**
  - Use […] as a predicate filter to select a *particular* context node
  - The predicate is evaluated as a boolean expression; if the condition is true, then the node is selected

```
<xsl:template match="author/name[middle]" >
  <!-- Match all name elements that have an     -->
  <!-- author parent and a middle child.        -->
</xsl:template>
```

```
<xsl:template match="/ROW/ROWSET[1]" >
  <!-- Match the first ROWSET element that is   -->
  <!-- a child of ROW (from the root).          -->
</xsl:template>
```

# Matching with Predicates (continued)

- **Matching a specific attribute**
  - Use the @ sign followed by the attribute name to select a particular node

```
<xsl:template match="order[@discount]" >
   <!-- Match all order elements that have a    -->
   <!-- discount attribute.                     -->
</xsl:template>
```

```
<xsl:template match="catalog/item[@id='3145']" >
  <!-- Match all item elements that are a child  -->
  <!-- of catalog and have an id attribute with  -->
  <!-- a value of 3145.                          -->
</xsl:template>
```

# XSLT Stylesheet Elements

- **Matching and selection templates**
  - xsl:template
  - xsl:apply-templates
  - xsl:value-of
- **Branching elements**
  - xsl:for-each
  - xsl:if
  - xsl:choose

# XSLT template Element

- **xsl:template match="*xpath*"**
  - Defines a template rule for producing output
  - Applied only to nodes which match the pattern
  - Invoked by using <xsl:apply-templates>

```
<xsl:template match="/">
  <html>
    <head><title>Ktee Siamese</title></head>
  <body>
    <xsl:apply-templates/>
  </body>
  </html>
</xsl:template>

<xsl:template match="name">
  <h2><xsl:value-of select="."/></h2>
</xsl:template>
```

# XSLT apply-templates Element

- **xsl:apply-templates**
  - Applies matching templates to the children of the context node

```
<xsl:template match="/">
  <html>
    <head><title>Ktee Siamese</title></head>
  <body>
    <xsl:apply-templates />
  </body>
  </html>
</xsl:template>

<xsl:template match="name">
  <h2><xsl:value-of select="."/></h2>
</xsl:template>
```

# XSLT value-of Element

- **`xsl:value-of select="`*`expression`*`"`**
  - Evaluates the expression as a string and sends the result to the output
  - Applied only to the first match
  - `". "` selects the text value of the current node

```
<xsl:template match="name">
  <!-- Select text of name node.   -->
  <h2><xsl:value-of select="." /></h2>
</xsl:template>
```

# XSLT value-of Element (continued)

- **Example**

```
<xsl:template match="daylily">
  <TR>
        <!-- Selects the award child of the
             daylily element. By default, outputs
             the text of the award element.       -->
    <TD><xsl:value-of select="award" /></TD>

        <!-- Selects the code attribute of the
             daylily's bloom child and outputs
             the text of the attribute.           -->
    <TD><xsl:value-of select="bloom/@code" /></TD>
  </TR>
</xsl:template>
```

# XSLT for-each Element

- **`xsl:for-each select="`*`expression`*`"`**
  - Processes each node selected by the XPath expression

```
<book>
  <author>Larry Brown</author>
  <author>Marty Hall</author>
</book>
```

---

```
<xsl:template match="book">
  <!-- Selects each author name.   -->
  <xsl:for-each select="author">
    <b><xsl:value-of select="." /></b>
  </xsl:for-each>
</xsl:template>
```

# XSLT if Element

- **`xsl:if test="expression"`**
  - Evaluates the expression to a boolean and if true, applies the template body
  - XSLT has no `if-else` construct (use `choose`)

```
<xsl:template match="ROW">
  <!-- Selects first node in the node set.   -->
  <xsl:if test="position() = first()">
    <b><xsl:value-of select="." />
  </xsl:if>
</xsl:template>

<xsl:template match="ROW">
  <!-- Select if the current node has children. -->
  <xsl:if test="node()">
    <xsl:apply-templates />
  </xsl:if>
</xsl:template>
```

# XSLT choose Element

- **`xsl:choose`**
  - Select any number of alternatives
  - Instruction to use in place of `if-else` or `switch` construct found in other programming languages

```
<xsl:choose>
  <xsl:when test="not(text())">
     Missing value!
  </xsl:when>
  <xsl:otherwise>
    <xsl:value-of select="." />
  </xsl:otherwise>
</xsl:choose>
```

# XSLT output Element

- **`xsl:output`**
  - Controls the format of the stylesheet output
  - Useful attributes:

```
method= "[html|xml|text]"
indent="[yes|no]"
version="version"
doctype-public="specification"
encoding="encoding"
standalone="[yes|no]"
```

- Example

```
<xsl:output method="html"
    doctype-public="-//W3C//DTD HTML 4.0 Transitional//EN"/>
```

# Steps for Translating a Document

1. Tell the system which parser to use
2. Establish a factory in which to create transformations
3. Create a transformer for a particular style sheet
4. Invoke the transformer to process the document

# Step 1: Specifying a Transformer

1. **Approaches to specify a transformer**
   - Set a system property for `javax.xml.transform.TransformerFactory`
   - Specify the parser in `jre_dir/lib/jaxp.properties`
   - Through the J2EE Services API and the class specified in `META-INF/services/javax.xml.transform.TransformerFactory`
   - Use system-dependant default parser (check documentation)

# Specifying a Transformer, Example

- **The following example:**
  - Permits the user to specify the transformer through the command line `-D` option

```
java -Djavax.xml.transform.TransformerFactory=
  weblogic.apache.xalan.processor.TransformerFactoryImpl ...
```

  - Uses the Apache Xalan transformer otherwise

```
public static void main(String[] args) {
  String jaxpPropertyName =
    "javax.xml.transform.TransformerFactory ";
  if (System.getProperty(jaxpPropertyName) == null) {
    String apacheXercesPropertyValue =
      "org.apache.xalan.xsltc.trax.TransformerFactoryImpl";
    System.setProperty(jaxpPropertyName,
                       apacheXercesPropertyValue);
  }
  ...
}
```

# Step 2: Creating a Transformer Factory

- **Establish a factory in which to create transformations**

```
TransformerFactory factory =
    new TransformerFactory.newInstance();
```

  - May create multiple transformers from the same factory

# Step 3: Creating a Transformer

- **Create a transformer for a particular style sheet**

```
Source xsl = new StreamSource(xslStream);
Templates template = factory.newTemplates(xsl);
Transformer transformer =
                    template.newTransformer();
```

# Step 4: Invoke the Transformer

- **Invoke the transformer to process the document**

```
Source xml = new StreamSource(xmlStream);
Result result = new StreamResult(outputStream);
transformer.transform(xml, result);
```

  - Create a `StreamSource` from a `File`, `Reader`, `InputStream` or URI reference (`String`)
  - Create a `StreamResult` from a `File`, `Writer`, `OutputStream` or URI reference (`String`)

# A Simple XSL Transformer

- **Creates an XSL transformer for processing an XML and XSL document**
  - Provides multiple overloaded `process` methods for handling different input and output streams

```
public class XslTransformer {
  private TransformerFactory factory;

  // Use system defaults for transformer.
  public XslTransformer() {
    factory =  TransformerFactory.newInstance();
  }
  ...
```

# A Simple XSL Transformer

```
/**  For transforming an XML documents as a String StringReader
  *  residing in memory, not on disk. The output document could
  *  easily be  handled as a String (StringWriter) or as a
  *  JSPWriter in a JavaServer page.
  */
 public void process(Reader xmlFile, Reader xslFile,
                     Writer output)
                 throws TransformerException {
   process(new StreamSource(xmlFile),
           new StreamSource(xslFile),
           new StreamResult(output));
 }

/**  For transforming an XML and XSL document as Files,
  *  placing the result in a Writer.
  */
 public void process(File xmlFile, File xslFile,
                     Writer output)
                 throws TransformerException {
   process(new StreamSource(xmlFile),
           new StreamSource(xslFile),
           new StreamResult(output));
 }
```

# Simple XSL Transformer (continued)

```
/**  Transform an XML File based on an XSL File, placing the
  *  resulting transformed document in an OutputStream.
  *  Convenient for handling the result as a FileOutputStream or
  *  ByteArrayOutputStream.
  */
public void process(Source xml, Source xsl, Result result)
                throws TransformerException {
   try {
     Templates template = factory.newTemplates(xsl);
     Transformer transformer = template.newTransformer();
     transformer.transform(xml, result);
   } catch(TransformerConfigurationException tce) {
       throw new TransformerException(tce.getMessageAndLocation());
   } catch (TransformerException te) {
     throw new TransformerException(te.getMessageAndLocation());
   }
 }
}
```

# Example 1: XSLT Document Editor

- **Objective**
  - Provide a graphical interface for editing XML and XSL documents, and to view the transformed result
- **Approach**
  - Use a Swing `JTabbedPane` with three tabs (XML, XSL, XSLT) to present each of the three corresponding documents
  - Each document is represented by a `JEditorPane`
    - XML and XSL panes are editable
  - Selecting the XSLT tab performs the transformation

# Example 1: XsltEditor

```
import java.awt.*;
import java.awt.event.*;
import javax.swing.*;
import javax.swing.event.*;
import java.io.*;
import javax.xml.transform.*;
import cwp.XslTransformer;

public class XsltEditor extends JFrame
                        implements ChangeListener {
  private static final int XML  = 0;
  private static final int XSL  = 1;
  private static final int XSLT = 2;
  private Action openAction, saveAction, exitAction;
  private JTabbedPane tabbedPane;
  private DocumentPane[] documents;
  private XslTransformer transformer;
  ...
```

# Example 1: XsltEditor (continued)

```
...
/** Checks to see which tabbed pane was selected by the
  *  user. If the XML and XSL panes hold a document, then
  *  selecting the XSLT tab will perform the transformation.
  */
 public void stateChanged(ChangeEvent event) {
   int index = tabbedPane.getSelectedIndex();
   switch (index) {
     case XSLT: if (documents[XML].isLoaded() &&
                    documents[XSL].isLoaded()) {
                  doTransform();
                }
     case XML:
     case XSL:  updateMenuAndTitle(index);
                break;
     default:
   }
 }
```

# Example 1: XsltEditor (continued)

```
  ...
  private void doTransform() {
    StringWriter strWriter = new StringWriter();
    try {
      Reader xmlInput =
        new StringReader(documents[XML].getText());
      Reader xslInput =
        new StringReader(documents[XSL].getText());
      transformer.process(xmlInput, xslInput, strWriter);
    } catch(TransformerException te) {
      JOptionPane.showMessageDialog(this,
                    "Error: " + te.getMessage());
    }
    documents[XSLT].setText(strWriter.toString());
  }
  ...
}
```

# Example 1: DocumentPane

```
public class DocumentPane extends JEditorPane {
  public static final String TEXT = "text/plain";
  public static final String HTML = "text/html";
  private boolean loaded = false;
  private String filename = "";

  /** Set the current page displayed in the editor pane,
   *  replacing the existing document.
   */
  public void setPage(URL url) {
    loaded = false;
    try {
      super.setPage(url);
      File file = new File(getPage().toString());
      setFilename(file.getName());
      loaded = true;
    } catch (IOException ioe) {
      System.err.println("Unable to set page: " + url);
    }
  }
```

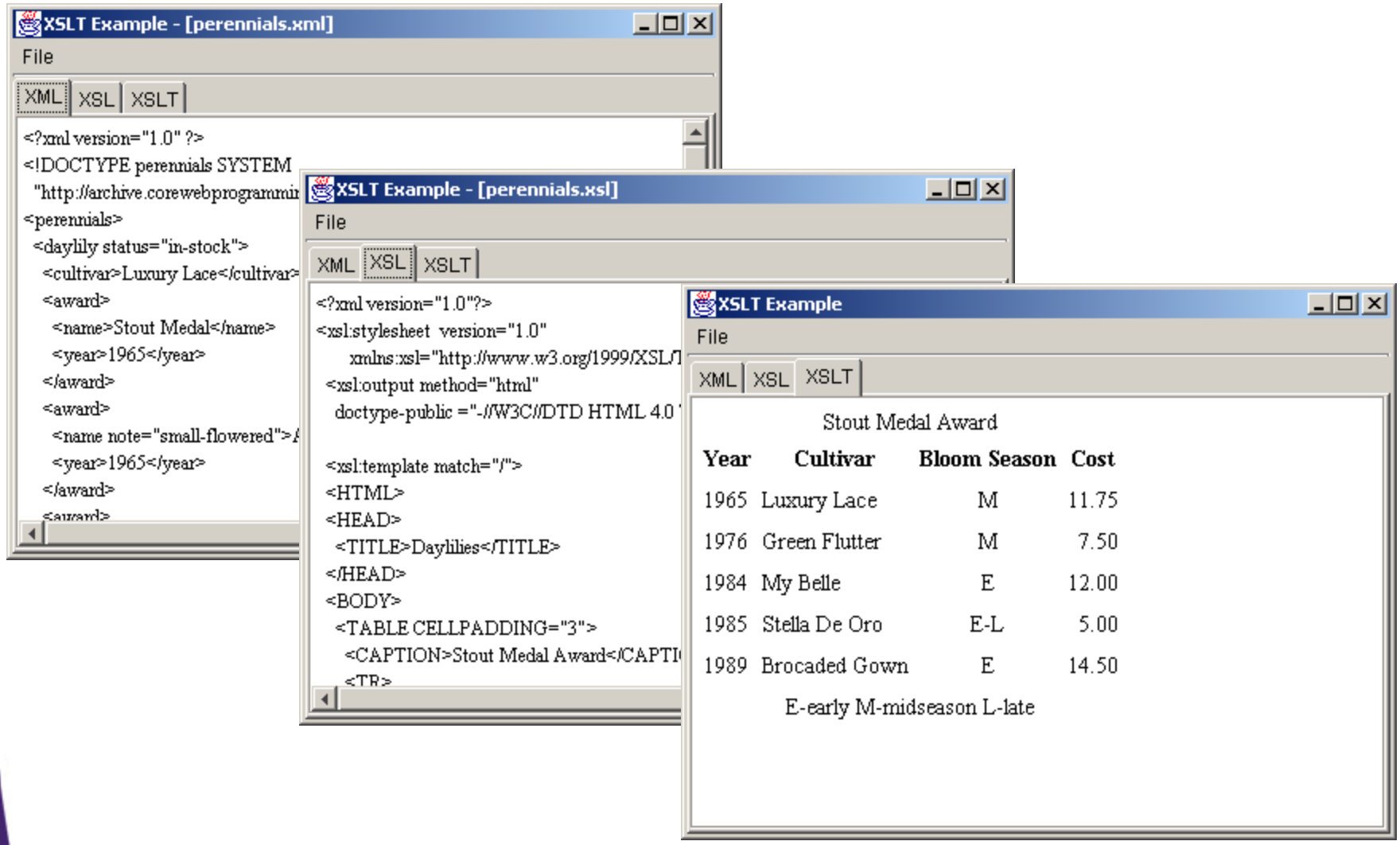
# Example 1: DocumentPane (continued)

```
  public void setText(String text) {
    super.setText(text);
    setFilename("");
    loaded = true;
  }

  public void loadFile(String filename) {
    try {
      File file = new File(filename);
      setPage(file.toURL());
    } catch (IOException mue) {
      System.err.println("Unable to load file: " + filename);
    }
  }

  public boolean isLoaded() {
    return(loaded);
  }
  ...
}
```

# Example 1: XsltEditor, Result



# Example 2: XSLT Custom Tag

- **Objective**
  - Develop a JSP custom tag to transform an XML document and create an HTML table
- **Problem**
  - THEAD, TBODY, and TFOOT elements supported by Internet Explorer, but not by Netscape 4.x

# Example 2: XSLT Custom Tag (continued)

- **Approach**
  - Use different stylesheet for Internet Explorer and Netscape
  - Determine the browser type based on the `User-Agent` HTTP header
  - Provide both stylesheets in custom tag

```
<cwp:xsltransform xml='perennials.xml'
                  xslie='perennials-ie.xsl'
                  xslns='perennials-ns.xsl' />
```

# Example 2: Custom Tag Specification, Xsltransform.tld

```
...
<tag>
  <name>xsltransform</name>
  <tagclass>cwp.tags.XslTransformTag</tagclass>
    <attribute>
    <name>xml</name>
    <required>yes</required>
  </attribute>
  <attribute>
    <name>xslie</name>
    <required>false</required>
  </attribute>
  <attribute>
    <name>xslns</name>
    <required>true</required>
  </attribute>
</tag>
```

# Example 2: XslTransformTag

```
public class XslTransformTag extends TagSupport {
  private static final int IE = 1;
  private static final int NS = 2;

  public int doStartTag() throws JspException {
    ServletContext context = pageContext.getServletContext();
    HttpServletRequest request =
      (HttpServletRequest)pageContext.getRequest();

    File xslFile = null;
    if ((browserType(request) == IE) &&
        (getXslie() != null)) {
      xslFile = new File(path + getXslie());
    } else {
      xslFile = new File(path + getXslns());
    }
    File xmlFile = new File(path + getXml());
    ...
```

# Example 2: XslTransformTag (continued)

```
    // doStartTag
    try {
      JspWriter out = pageContext.getOut();
      XslTransformer transformer = new XslTransformer();
      transformer.process(xmlFile, xslFile, out);
    }
    catch(TransformerException tx) {
      context.log("XslTransformTag: " + tx.getMessage());
    }
    return(SKIP_BODY);
  }
  ...
```

# Example 2: XslTransformTag (continued)

```
  // Determine the browser type based on the User-Agent
  // HTTP request header.

  private int browserType(HttpServletRequest request) {
    int type = NS;
    String userAgent = request.getHeader("User-Agent");
    if ((userAgent != null) &&
        (userAgent.indexOf("IE") >= 0)) {
      type = IE;
    }
    return(type);
  }
}
```

# Example 2: Daylilies.jsp

```
<HTML>
<HEAD>
  <TITLE>Daylilies</TITLE>
</HEAD>
<BODY>
<%@ taglib uri="cwp-tags/xsltransform.tld" prefix="cwp" %>

<H1 ALIGN="CENTER">Katie's Favorite Daylilies</H1>
<P>
<cwp:xsltransform xml='perennials.xml'
                  xslie='perennials-ie.xsl'
                  xslns='perennials-ns.xsl' />

</BODY>
</HTML>
```

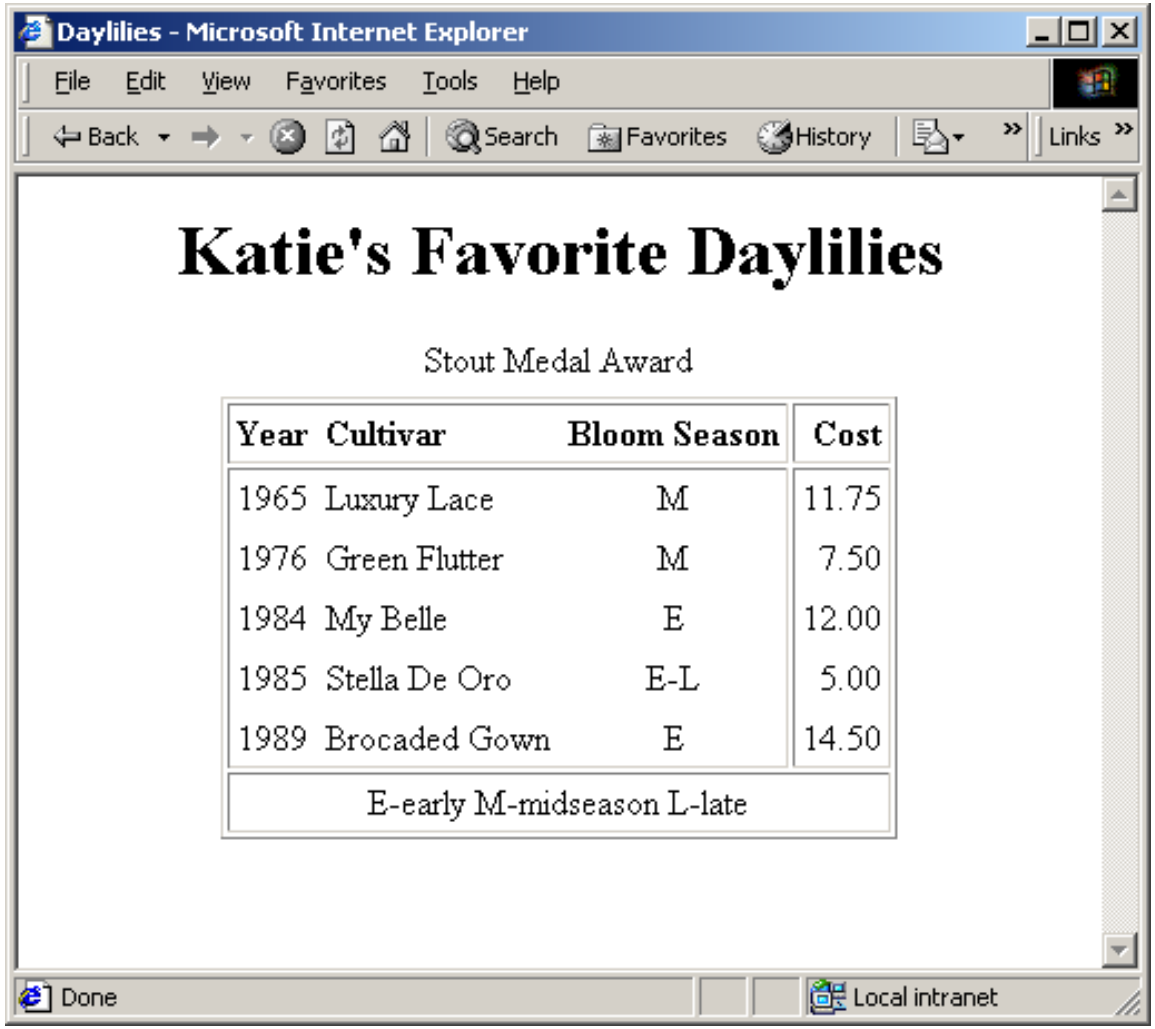
# Example 2: perennials-ie.xsl

```
<xsl:template match="/">
 <TABLE CELLPADDING="3" RULES="GROUPS" ALIGN="CENTER">
   <CAPTION>Stout Medal Award</CAPTION>
   <COLGROUP>
     <COL ALIGN="CENTER"/>
     <COL ALIGN="LEFT"/>
     <COL ALIGN="CENTER"/>
     <COL ALIGN="RIGHT"/>
   </COLGROUP>
   <THEAD>
     <TR><TH>Year</TH><TH>Cultivar</TH><TH>Bloom Season</TH>
         <TH>Cost</TH></TR>
   </THEAD>
   <TBODY>
     <xsl:apply-templates
       select="/perennials/daylily[award/name='Stout Medal']"/>
   </TBODY>
   <TFOOT>
     <TR><TD COLSPAN="4">E-early M-midseason L-late</TD></TR>
   </TFOOT>
 </TABLE>
</xsl:template>
```

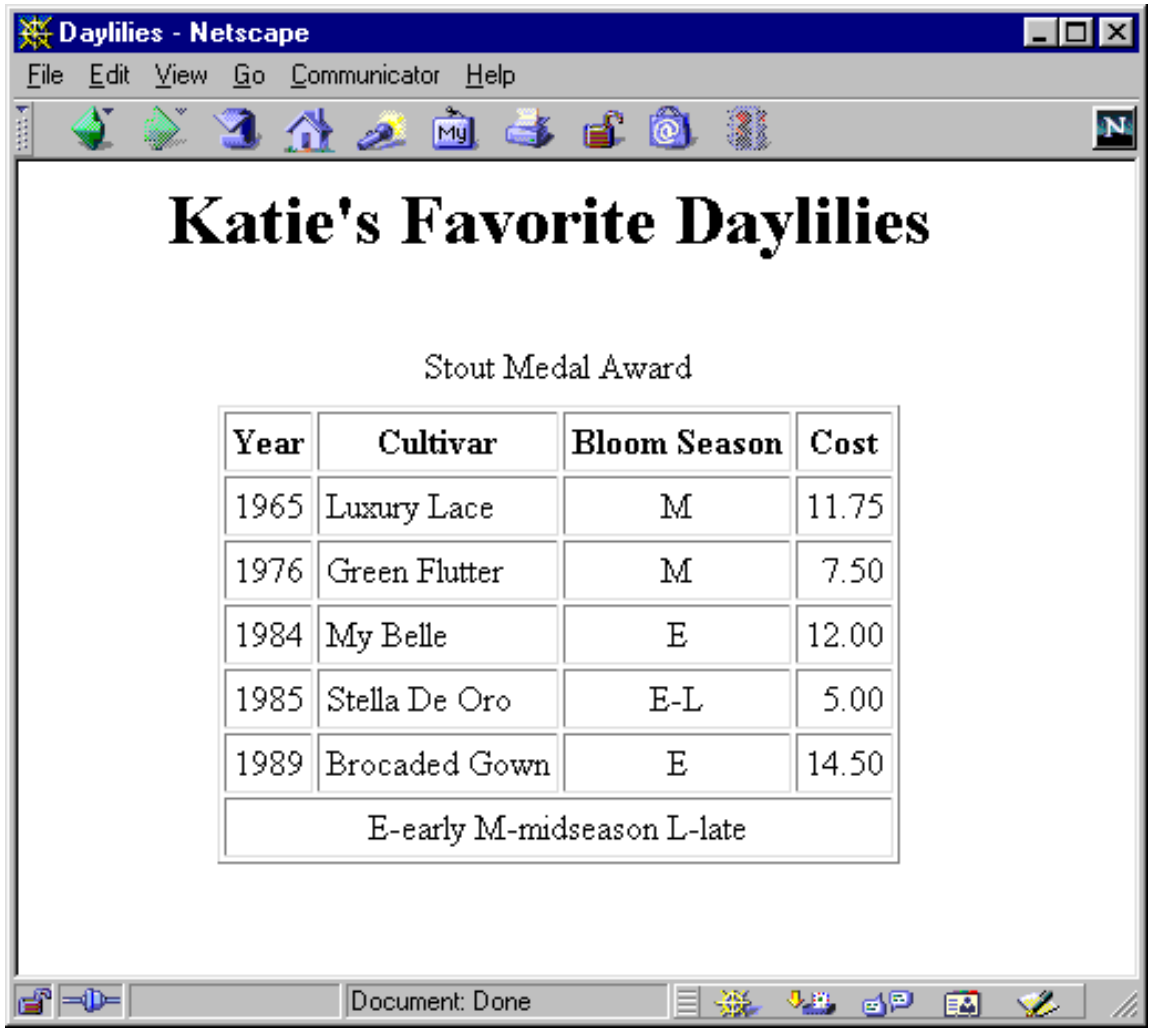
# Example 2: perennials-ns.xsl

```
<xsl:template match="/">
  <TABLE CELLPADDING="3" BORDER="1" ALIGN="CENTER">
    <CAPTION>Stout Medal Award</CAPTION>
    <TR>
      <TH>Year</TH>
      <TH>Cultivar</TH>
      <TH>Bloom Season</TH>
      <TH>Cost</TH>
    </TR>
    <xsl:apply-templates
      select="/perennials/daylily[award/name='Stout Medal']"/>
    <TR>
      <TD COLSPAN="4" ALIGN="CENTER">
        E-early M-midseason L-late</TD>
    </TR>
  </TABLE>
</xsl:template>
```

# XSLT Custom Tag, Result



# XSLT Custom Tag, Result



# Summary

- **XSLT specifies how to transform XML into HTML, XML, or other document formats**
- **XPath pattern selects a set of nodes for processing**
- **Control conditional processing through XSLT templates (elements)**
- **Apache Xalan-J in a popular XLST compliant transformer**
  - `InputSource` document is typically a `File` or `String` (`StringReader`)
  - `Result` document typically sent to a `File` or `JspWriter` in a servlet