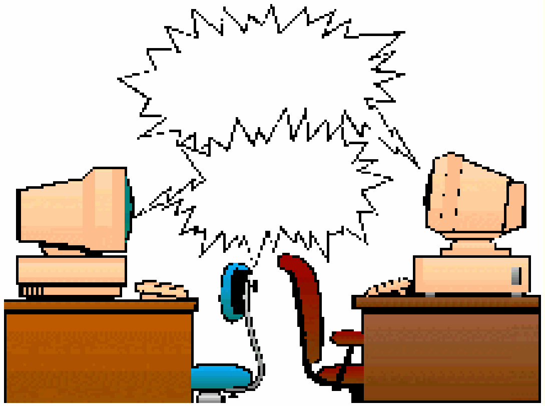
Database Management Systems
Session 7



Instructor: Vinnie Costa
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Term Paper

- Due Next Saturday, Oct 8
- Should be about 3-4 pages (9 or 10 font)

Homework

- Read Chapter Six
- Any Questions?

MidTerm Exam

- Any not get there's?

An Innocent Idea…Whoops!

William Bright, 27, displays his iPod with a subway map display outside a SoHo subway station in New York Thursday, Sept. 29, 2005.

Tens of thousands of people have downloaded maps Bright created in early August.

San Francisco and New York City officials were less enthusiastic.

Bright received a "cease and desist" letter from a lawyer for the Metropolitan Transit Authority.

http://www.ipodsubwaymaps.com

Internet Applications

"On the Internet, nobody knows you're a dog."

Chapter 7

Lecture Overview

- Internet Concepts
- Web data formats
    - HTML, XML, DTDs
- Introduction to three-tier architectures
- The presentation layer
    - HTML forms, HTTP Get and POST, URL encoding, Javascript, Stylesheets, XSLT
- The middle tier
    - CGI, application servers, Servlets, JavaServerPages, passing arguments, maintaining state (cookies)

Uniform Resource Identifiers

- Uniform naming schema to identify **resources** on the Internet
- A resource can be anything:
  - `index.html`
  - `mysong.mp3`
  - `picture.jpg`
- Example URIs:

```
http://www.cs.wisc.edu/~dbbook/index.html
mailto:webmaster@bookstore.com
```

Structure of URIs

`http://www.cs.wisc.edu/~dbbook/index.html`

- URI has three parts:
  - **Naming schema** (http)
  - **Name of the host computer** (www.cs.wisc.edu)
  - **Name of the resource** (~dbbook/index.html)

- URLs are a subset of URIs

Hypertext Transfer Protocol

- What is a communication protocol?
  - Set of standards that defines the structure of messages
  - Examples: TCP, IP, HTTP
- What happens if you click on **`www.cs.wisc.edu/~dbbook/index.html`**?
  - Client (web browser) sends HTTP request to server
  - Server receives request and replies
  - Client receives reply; makes new requests

HTTP (Contd.)

Client to Server:

```
GET ~/index.html HTTP/1.1
User-agent: Mozilla/4.0
Accept: text/html, image/gif,
   image/jpeg
```

Server replies:

```
HTTP/1.1 200 OK
Date: Mon, 04 Mar 2002
   12:00:00 GMT
Server: Apache/1.3.0 (Linux)
Last-Modified: Mon, 01 Mar
   2002 09:23:24 GMT
Content-Length: 1024
Content-Type: text/html
<HTML> <HEAD></HEAD>
<BODY>
<h1>Barns and Nobble Internet
   Bookstore</h1>
Our inventory:
<h3>Science</h3>
<b>The Character of Physical
   Law</b>
...
```

HTTP Protocol Structure

HTTP Requests

- Request line: `GET ~/index.html HTTP/1.1`
  - `GET`: Http method field (possible values are GET and POST, more later)
  - `~/index.html`: URI field
  - `HTTP/1.1`: HTTP version field
- Type of client: `User-agent: Mozilla/4.0`
- What types of files will the client accept:

```
Accept: text/html, image/gif, image/jpeg
```

HTTP Protocol Structure (Contd.)

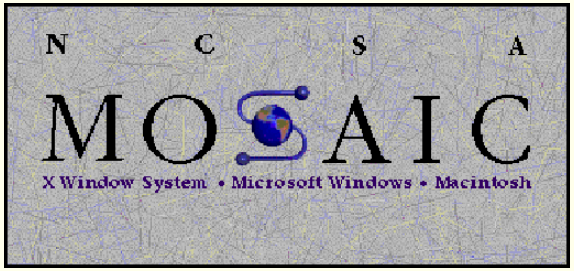
HTTP Responses

- Status line: **`HTTP/1.1 200 OK`**
  - HTTP version: **`HTTP/1.1`**
  - Status code: **`200`**
  - Server message: **`OK`**
  - Common status code/server message combinations:
    - **`200 OK`**: Request succeeded
    - **`400 Bad Request`**: Request could not be fulfilled by the server
    - **`404 Not Found`**: Requested object does not exist on the server
    - **`505 HTTP Version not Supported`**
- Date when the object was created:

  `Last-Modified: Mon, 01 Mar 2002 09:23:24 GMT`
- Number of bytes being sent: **`Content-Length: 1024`**
- What type is the object being sent: **`Content-Type: text/html`**
- Other information such as the server type, server time, etc.

A Simple Idea

- **Marc Andreessen**, born in Iowa, 1971, received his BA in computer science from the University of Illinois, Urbana-Champaign, where research was being done at the university's **National Center for Supercomputing Applications** on early browsers such as **ViolaWWW** (created by **Pei-Yuan Wei** in 1993), based on **Tim Berners-Lee's** open standards for the **World Wide Web**.



- These earlier browsers had been created to work only on expensive Unix workstations, so Andreessen and a full-time salaried co-worker Eric Bina worked on creating an improved and user-friendlier version with integrated graphics that would work on personal computers. The resulting code was the Mosaic web browser.

- After graduating, he teamed up with with **Jim Clark**, the founder of **Silicon Graphics**, and formed the **Mosaic Communications Corporation** in Mountain View, California, with Andreessen appointed as a vice-president. The University of Illinois was unhappy with the use of the Mosaic name, so Mosaic Communications changed its name to **Netscape Communications**, and its flagship web browser was the **Netscape Navigator**.

- **http://www.ibiblio.org/pioneers/andreesen.html**

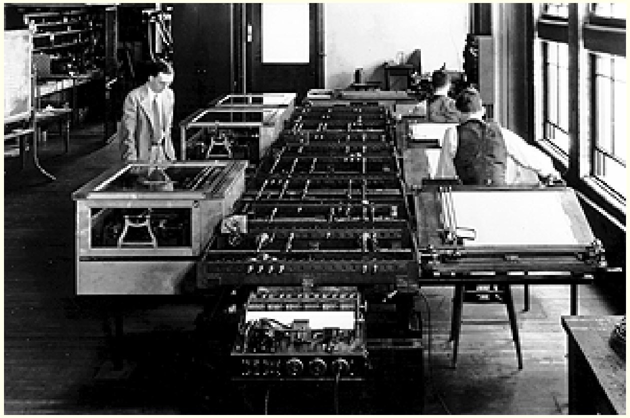
A Previous Simple Idea

- **Vannevar Bush**, born 1890, in Chelsea, Massachusetts, was never directly involved with the creation or development of the Internet. Yet many consider Bush to be the Godfather of our wired age often making reference to his 1945 essay, "**As We May Think**."

- In his article, Bush described a theoretical machine he called a "**memex,"** which was to enhance human memory by allowing the user to store and retrieve documents linked by **associations** (what he called **associative trails**). This associative linking was very similar to what is known today as **hypertext**.

- Vannevar Bush died on June 30, 1974, years before the Internet became widely popular or the World Wide Web even existed. With the growing popularity of the Internet many now look back through its history and see Bush as a visionary.

- **http://www.ibiblio.org/pioneers/bush.html**



Differential Analyzer - 1931

Some Remarks About HTTP

- HTTP is **stateless**
  - **No "sessions"**
  - Every message is completely self-contained
  - **No** previous interaction is "**remembered**" by the protocol
  - Tradeoff between ease of implementation and ease of application development: Other functionality has to be built on top
- Implications for applications:
  - Any state information (shopping carts, user login-information) need to be encoded in every HTTP request and response!
  - Popular **methods** on how to **maintain state**:
    - **Cookies** (later this lecture)
    - Dynamically generate **unique URL's at the server level** (later this lecture)

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Web Data Formats

- **HTML**
  - The presentation language for the Internet
- **XML**
  - A self-describing, hierarchal data model
- **DTD**
  - Standardizing schemas for Xml
- **XSLT** (not covered in the book)

HTML: An Example

```
<HTML>
    <HEAD></HEAD>
    <BODY>
    <h1>Barns and Nobble Internet
   Bookstore</h1>
    Our inventory:

    <h3>Science</h3>
    <b>The Character of Physical
   Law</b>
    <UL>
        <LI>Author: Richard
   Feynman</LI>
   <LI>Published 1980</LI>
   <LI>Hardcover</LI>
    </UL>
```

```
  <h3>Fiction</h3>
    <b>Waiting for the Mahatma</b>
    <UL>
   <LI>Author: R.K. Narayan</LI>
   <LI>Published 1981</LI>
    </UL>
    <b>The English Teacher</b>
    <UL>
   <LI>Author:  R.K. Narayan</LI>
   <LI>Published 1980</LI>
   <LI>Paperback</LI>
    </UL>


    </BODY>
</HTML>
```

HTML: A Short Introduction

- HTML is a **markup language**
- Commands are tags:
  - **Start tag** and **end tag**
  - Examples:
    - `<HTML> … </HTML>`
    - `<UL> … </UL>`
- Many editors automatically generate HTML directly from your document (e.g., Microsoft Word has an "Save as html" facility)
- **Nvu** is perfect for this

HTML: Sample Commands

- **`<HTML>`** - starts the document
- **`<UL>`** - unordered list
- **`<LI>`** - list entry
- **`<h1>`** - largest heading
- **`<h2>`** - second-level heading, **`<h3>, <h4>`** analogous
- **`<B>`**Title**`</B>`** - bold

XML: An Example

```xml
<?xml version="1.0" encoding="UTF  8' standalone="yes"?>
<BOOKLIST>
    <BOOK genre="Science" format="Hardcover">
        <AUTHOR>
            <FIRSTNAME>Richard</FIRSTNAME><LASTNAME>Feynman</LASTNAME>
        </AUTHOR>
        <TITLE>The Character of Physical Law</TITLE>
        <PUBLISHED>1980</PUBLISHED>
    </BOOK>
    <BOOK genre="Fiction">
        <AUTHOR>
            <FIRSTNAME>R.K.</FIRSTNAME><LASTNAME>Narayan</LASTNAME>
        </AUTHOR>
        <TITLE>Waiting for the Mahatma</TITLE>
        <PUBLISHED>1981</PUBLISHED>
    </BOOK>
    <BOOK genre="Fiction">
        <AUTHOR>
            <FIRSTNAME>R.K.</FIRSTNAME><LASTNAME>Narayan</LASTNAME>
        </AUTHOR>
        <TITLE>The English Teacher</TITLE>
        <PUBLISHED>1980</PUBLISHED>
    </BOOK>
</BOOKLIST>
```

XML – The Extensible Markup Language

- **Language**
  - A way of communicating information
- **Markup**
  - Notes or meta-data that describe your data or language
- **Extensible**
  - Limitless ability to define new languages or data sets

XML – What's The Point?

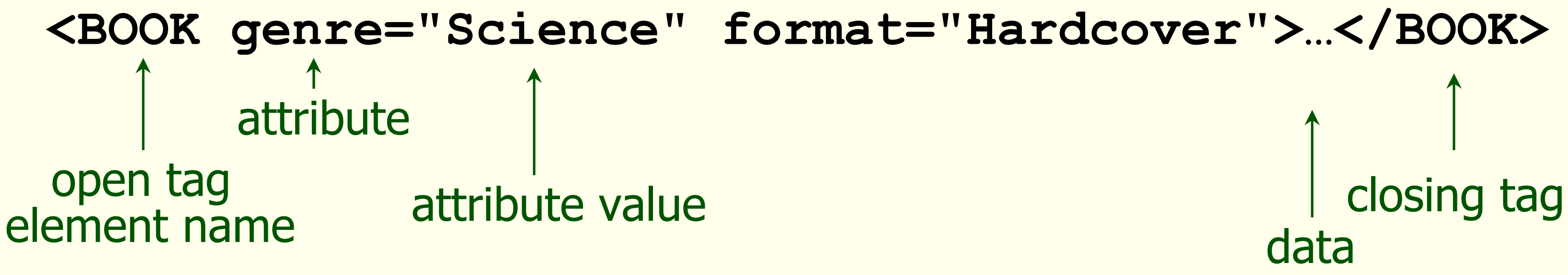
- You can include your data and a description of what the data represents
  - This is useful for defining your own language or protocol
- Example: Chemical Markup Language

```
<molecule>
       <weight>234.5</weight>
       <Spectra>…</Spectra>
       <Figures>…</Figures>
</molecule>
```

- XML design goals:
  - XML should be compatible with **SGML**
  - It should be easy to write XML processors
  - The design should be formal and precise

XML – Structure

- **XML** - Confluence of SGML and HTML
- XML looks like HTML
- XML is a hierarchy of user-defined tags called elements with attributes and data
- Data is described by **elements**, elements are described by **attributes**



```
<BOOK genre="Science" format="Hardcover">…</BOOK>
```

attribute

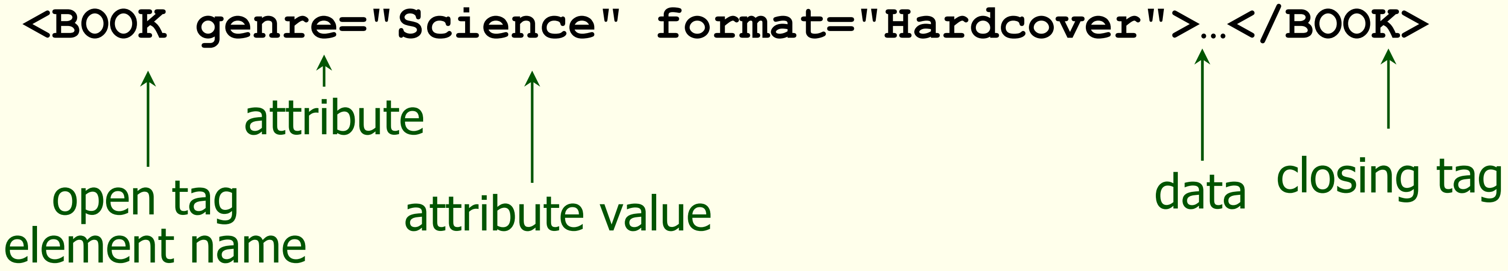
open tag
element name

attribute value

closing tag

data

XML – Elements



```
<BOOK genre="Science" format="Hardcover">…</BOOK>
```

attribute

open tag
element name

attribute value

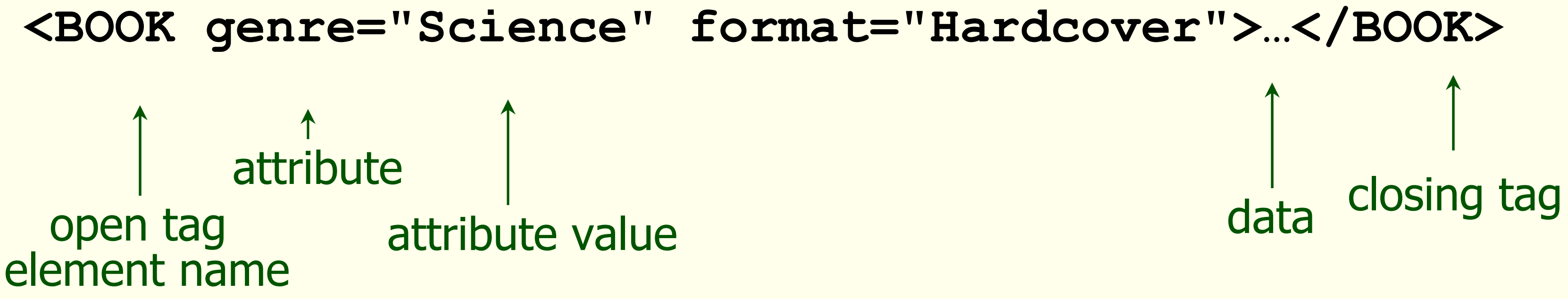
data

closing tag

- XMLis **case** and **space sensitive**
- Element **opening** and **closing tag names** must be **identical**
- Opening tags: “**<**” + element name + “**>**”
- Closing tags: “**</**” + element name + “**>**”
- Empty Elements have no data and no closing tag:
  - They begin with a “**<**“ and end with a “**/>**”

```
<BOOK/>
```

XML – Attributes



```
<BOOK genre="Science" format="Hardcover">…</BOOK>
```

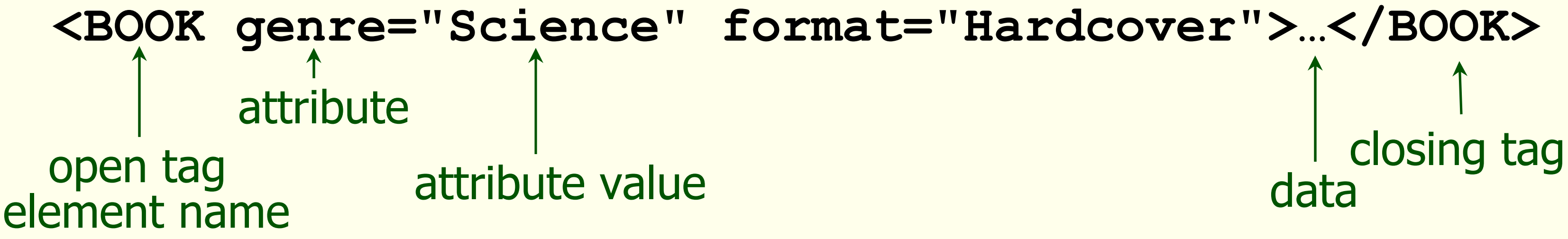
- **Attributes** provide **additional information** for element tags.
- There can be **zero or more attributes** in every element; each one has the the form:

  attribute_name=‘attribute_value’

  - There is **no space** between the name and the "**=**‘"
  - **Attribute values** must be surrounded by **"** or **'** characters

- **Multiple attributes** are **separated by white space** (one or more spaces or tabs).

XML – Data and Comments



`<BOOK genre="Science" format="Hardcover">…</BOOK>`

open tag
element name

attribute

attribute value

data

closing tag

- XML data is any information between an opening and closing tag
- XML data must not contain the ‘**<**‘ or ‘**>**’ characters

- Comments:
  `<!-` comment **`->`**

XML – Nesting & Hierarchy

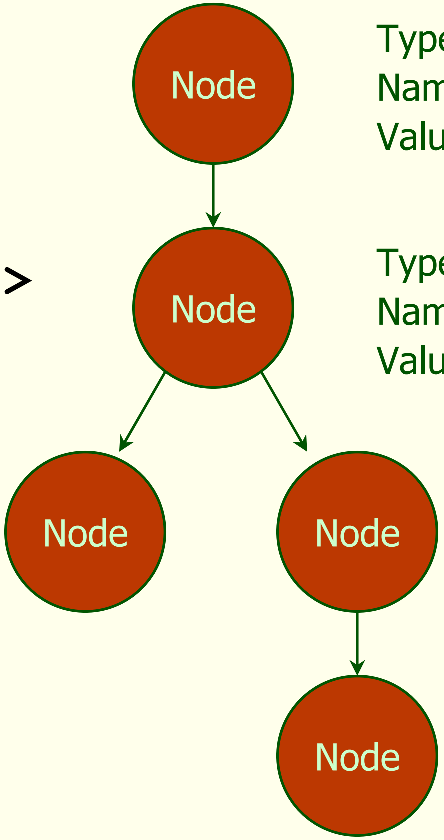
- XML tags can be **nested** in a **tree hierarchy**
- XML documents can have **only one root tag**
- Between an opening and closing tag you can insert:
  1. Data
  2. More Elements
  3. A combination of data and elements

```
<root>
    <tag1>
        Some Text
        <tag2>More</tag2>
    </tag1>
</root>
```

XML – Storage

- Storage is done just like an n-ary tree (DOM)

```
<root>
    <tag1>
        Some Text
        <tag2>More</tag2>
    </tag1>
</root>
```



Type: Element_Node
Name: Element
Value: **Root**

Type: Element_Node
Name: Element
Value: **tag1**

Type: Text_Node
Name: Text
Value: **Some Text**

Type: Element_Node
Name: Element
Value: **tag2**

Type: Text_Node
Name: Text
Value: **More**

DTD – Document Type Definition

- A **DTD** is a **schema** for XML data
- XML protocols and languages can be **standardized with DTD files**
- A DTD says what elements and attributes are required or optional
  - Defines the **formal structure** of the language

DTD – An Example

```
<?xml version='1.0'?>
<!ELEMENT Basket (Cherry+, (Apple | Orange)*) >
    <!ELEMENT Cherry EMPTY>
          <!ATTLIST Cherry flavor CDATA #REQUIRED>
    <!ELEMENT Apple EMPTY>
          <!ATTLIST Apple color CDATA #REQUIRED>
    <!ELEMENT Orange EMPTY>
          <!ATTLIST Orange location ‘Florida’>
------------------------------------------------------------------
```

☺

```
<Basket>
    <Cherry flavor=‘good’/>
    <Apple color=‘red’/>
    <Apple color=‘green’/>
</Basket>
```

☹

```
<Basket>
    <Apple/>
    <Cherry flavor=‘good’/>
    <Orange/>
</Basket>
```

DTD - !ELEMENT

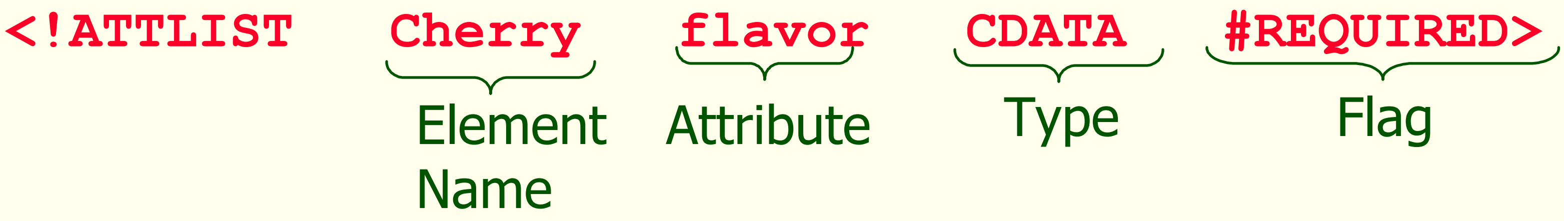
$$\texttt{<!ELEMENT } \underbrace{\texttt{Basket}}_{\text{Name}} \ \underbrace{\texttt{(Cherry+, (Apple | Orange)}}_{\text{Children}}\texttt{*) >}$$

- **`!ELEMENT`** declares an element name, and what children elements it should have
- Content types:
  - **Other elements**
  - **`#PCDATA`** (parsed character data)
  - **`EMPTY`** (no content)
  - **`ANY`** (no checking inside this structure)
  - A regular expression

DTD - !ELEMENT (Contd.)

- A **regular expression** has the following structure:
  - **exp_1, exp_2, exp_3, …, exp_k** - A list of regular expressions
  - **exp*** - An optional expression with zero or more occurrences
  - **exp+** - An optional expression with one or more occurrences
  - **exp_1 | exp_2 | … | exp_k** - A disjunction of expressions

DTD - !ATTLIST



```
<!ATTLIST    Cherry    flavor    CDATA    #REQUIRED>
```

```
<!ATTLIST Orange  location CDATA #REQUIRED
                  color ‘orange’>
```

- **`!ATTLIST`** defines a list of **attributes** for an element
- Attributes can be of **different types**, can be **required or not required**, and they can have **default values**

DTD – Well-Formed and Valid

```
<?xml version='1.0'?>
<!ELEMENT Basket (Cherry+)>
   <!ELEMENT Cherry EMPTY>
       <!ATTLIST Cherry flavor CDATA #REQUIRED>
--------------------------------------------------------------------
```

Not Well-Formed

```
<basket>
   <Cherry flavor=good>
</Basket>
```

Well-Formed but Invalid

```
<Job>
   <Location>Home</Location>
</Job>
```

Well-Formed and Valid

```
<Basket>
   <Cherry flavor=‘good’/>
</Basket>
```

XML and DTDs

- More and more **standardized DTDs** will be developed
  - MathML
  - Chemical Markup Language
- Allows **light-weight exchange of data** with the same semantics
- Sophisticated **query languages** for XML are available:
  - **Xquery**
  - **XPath**

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Components of Data-Intensive Systems

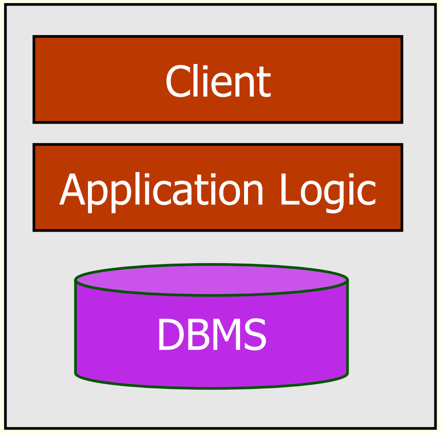
Three separate types of functionality:

- **Data management**
- **Application logic**
- **Presentation**

- The system architecture determines whether these three components reside on a single system (“tier” or are distributed across several tiers

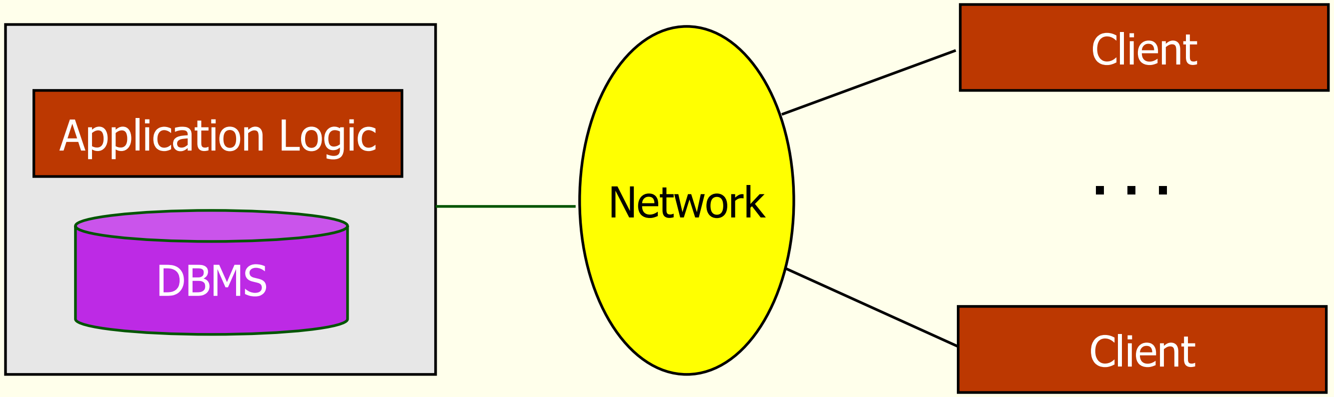
Single-Tier Architectures

- All functionality combined into a single tier, usually on a mainframe
  - User access through dumb terminals
- Advantages:
  - Easy maintenance and administration
- Disadvantages:
  - Today, users expect graphical user interfaces.
  - Centralized computation of all of them is too much for a central system



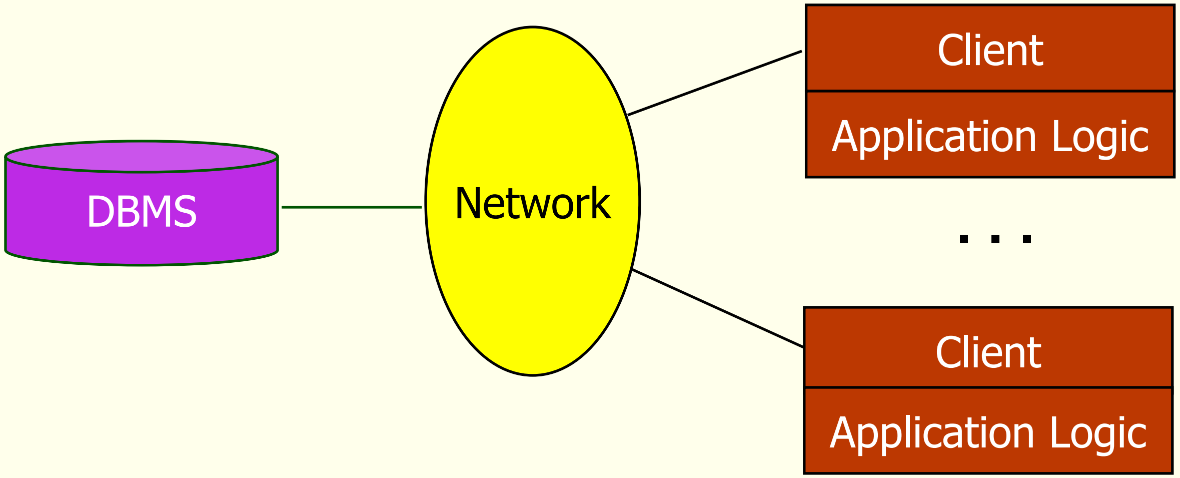
Client-Server Architectures

- Work division: **Thin client**
  - Client implements only the graphical user interface
  - Server implements business logic and data management



Client-Server Architectures

- Work division: **Thick client**
  - Client implements both the graphical user interface and the business logic
  - Server implements data management

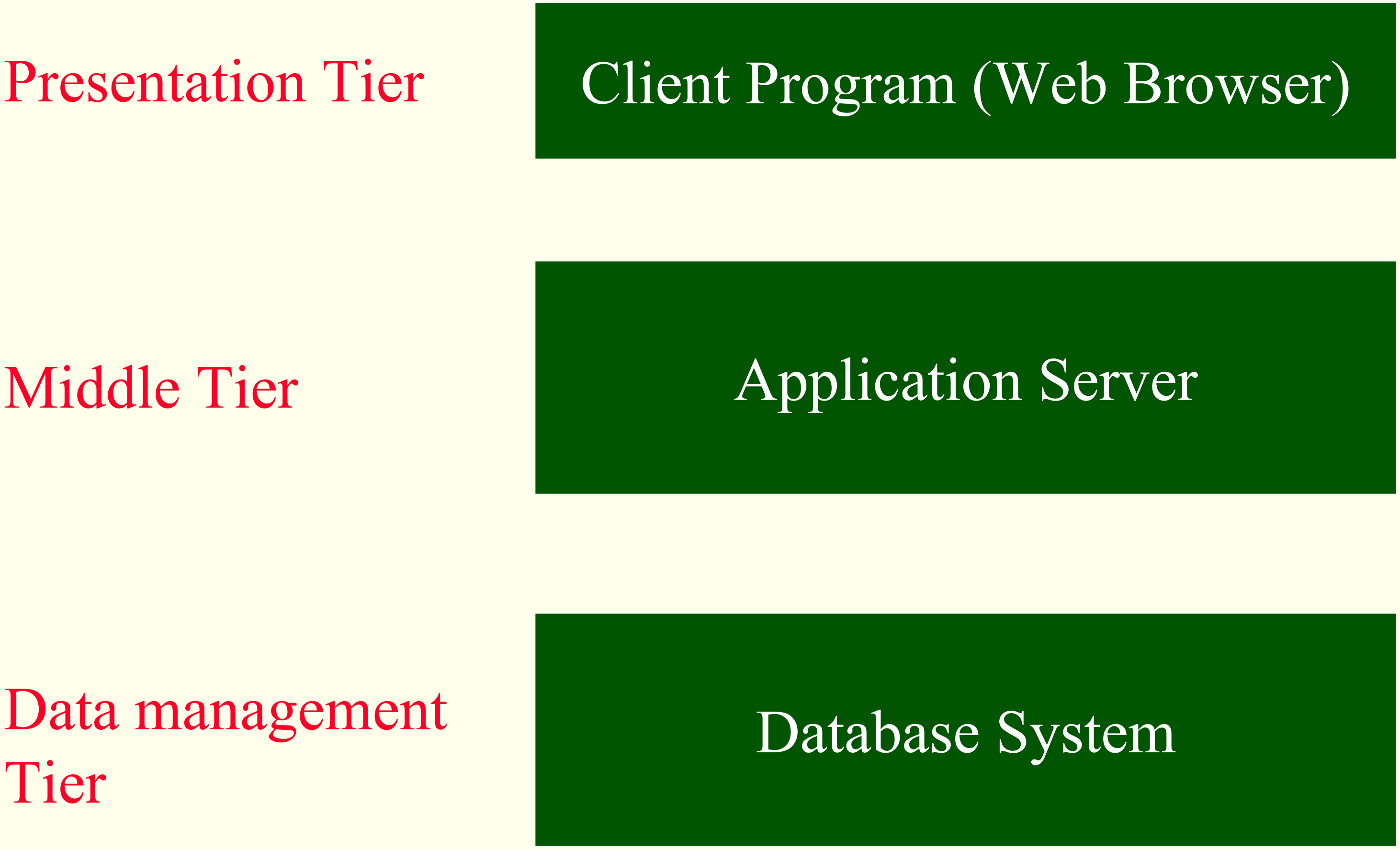


Client-Server Architectures (Contd.)

Disadvantages of **thick clients:**

- **No central** place to update the business logic
- Security issues: Server needs to trust clients
  - **Access control** and authentication needs to be **managed at the server**
  - Clients need to leave server database in consistent state
  - One possibility: Encapsulate all database access into **stored procedures**
- **Does not scale** to more than several 100s of clients
  - Large data transfer between server and client
  - More than one server creates a problem: x clients, y servers: **x * y** connections

The Three-Tier Architecture



Presentation Tier

Client Program (Web Browser)

Middle Tier

Application Server

Data management Tier

Database System

The Three Layers

Presentation tier

- Primary interface to the user
- Needs to adapt to different display devices (PC, PDA, cell phone, voice access?)

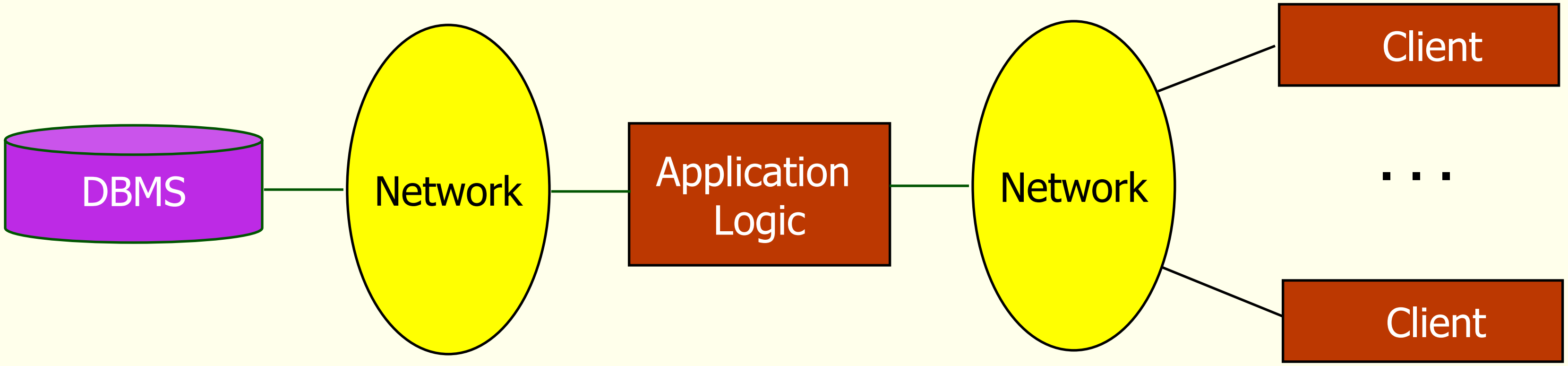
Middle tier

- Implements business logic (implements complex actions, maintains state between different steps of a workflow)
- Accesses different data management systems

Data management tier

- One or more standard database management systems

Three-Tier Architecture



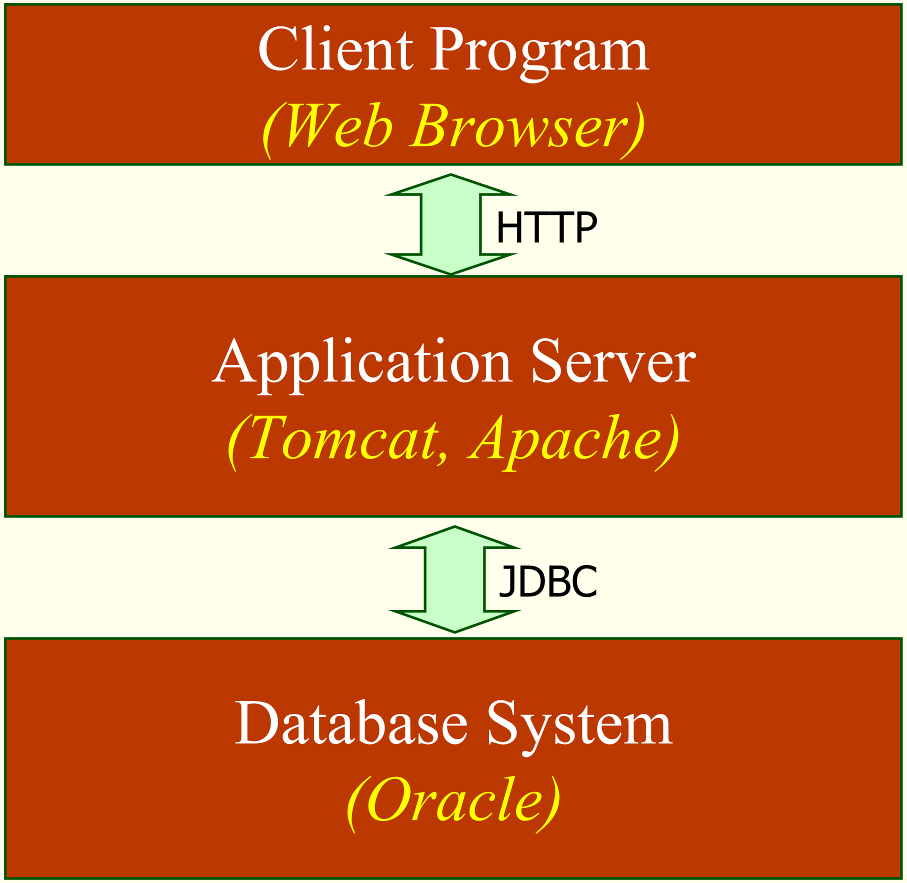
Example 1: Airline reservations

- Build a system for making airline reservations
- What is done in the different tiers?
- Database System
  - Airline info, available seats, customer info, etc.
- Application Server
  - Logic to make reservations, cancel reservations, add new airlines, etc.
- Client Program
  - Log in different users, display forms and human-readable output

Example 2: Course Enrollment

- Build a system using which students can enroll in courses
- Database System
  - Student info, course info, instructor info, course availability, pre-requisites, etc.
- Application Server
  - Logic to add a course, drop a course, create a new course, etc.
- Client Program
  - Log in different users (students, staff, faculty), display forms and human-readable output

Technologies



Client Program

(Web Browser)

HTTP

Application Server

(Tomcat, Apache)

JDBC

Database System

(Oracle)

HTML
Javascript
XSLT

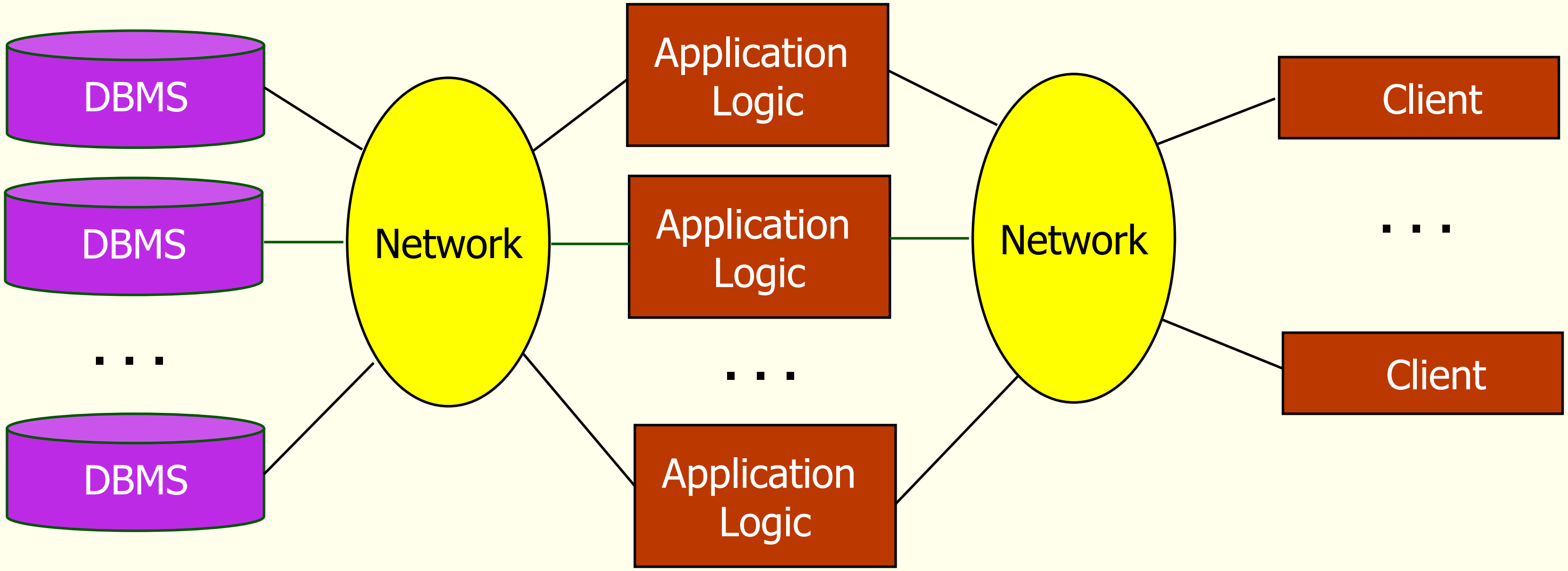
JSP
Servlets
Cookies
CGI

XML
Stored Procedures

Advantages of the Three-Tier Architecture

- **Heterogeneous systems**
  - Tiers can be independently maintained, modified, and replaced
- **Thin clients**
  - Only presentation layer at clients (web browsers)
- **Integrated data access**
  - Several database systems can be handled transparently at the middle tier
  - Central management of connections
- **Scalability**
  - Replication at middle tier permits scalability of business logic
- **Software development**
  - Code for business logic is centralized
  - Interaction between tiers through well-defined APIs: Can reuse standard components at each tier

Scalable Three-Tier Architecture



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Overview of the Presentation Tier

- **Recall: Functionality of the presentation tier**
  - Primary interface to the user
  - Needs to adapt to different display devices (PC, PDA, cell phone, voice access?)
  - Simple functionality, such as field validity checking
- We will cover:
  - **HTML Forms** - How to pass data to the middle tier
  - **JavaScript** - Simple functionality at the presentation tier
  - **Style sheets** - Separating data from formatting

HTML Forms

- Common way to communicate data from client to middle tier
- General format of a form:

  -
    ```
    <FORM ACTION=“page.jsp” METHOD=“GET”
           NAME=“LoginForm”>
    …
    </FORM>
    ```
- Components of an HTML FORM tag:
  - **ACTION** - Specifies URI that handles the content
  - **METHOD** - Specifies HTTP GET or POST method
  - **NAME** - Name of the form - can be used in client-side scripts to refer to the form

Inside HTML Forms

- **`INPUT`** tag
  - Attributes:
    - **`TYPE`** - **text** (text input field), **password** (text input field where input is displayed as stars), **reset** (resets all input fields)
    - **`NAME`** - **symbolic name**, used to identify field value at the middle tier
    - **`VALUE`** - **default** value
  - Example: **`<INPUT TYPE=“text” Name=“title”>`**
- Example form:

```
<FORM ACTION="TableOfContents.jsp“ METHOD="POST" >
  <INPUT TYPE="text" NAME="username"><P>
  <INPUT TYPE="password" NAME="password"><P>
  <INPUT TYPE=“reset” VALUE=“Rest Values”><P>
  <INPUT TYPE="submit" VALUE="Login“>
</FORM>
```

Passing Arguments

Two methods: **GET** and **POST**

- **`GET`**
  - Form contents go into the submitted URI (visible to user)
  - Structure:
    `action?name1=value1&name2=value2&name3=value3`
    - **`action`** - name of the URI specified in the form
    - (**`name,value`**) -pairs come from INPUT fields in the form; empty fields have empty values (“name=“)
  - Example from previous password form:
    `TableOfContents.jsp?username=john&password=johnpw`
  - Note that the page named **`action`** needs to be a program, script, or page that will process the user input
- **`POST`**
  - Form contents are encoded but sent in separate data block as part of the message body (not visible to user)

HTTP GET: Encoding Form Fields

- FORM fields can contain general **ASCII characters** that **cannot appear in an URI**
- A special encoding convention converts such field values into “**URI-compatible**” characters:
  - Convert all “special” characters to **%xyz**, were xyz is the ASCII code of the character. Special characters include **&, =, +, %, etc.**
  - Convert all **spaces** to the “**+**” character
  - **Glue** (name,value)-pairs from the form INPUT tags together with “**&**” to form the URI

HTML Forms: A Complete Example

```
<FORM METHOD="POST" ACTION="TableOfContents.jsp">
   <table align = "center" border="0" width="300">
   <tr>
        <td>Userid</td>
        <td><INPUT TYPE="text" NAME="userid" SIZE="20"></td>
   </tr>
   <tr>
        <td>Password</td>
        <td><INPUT TYPE="password" NAME="password“ SIZE="20"></td>
   </tr>
   <tr>
        <td align = "center"><INPUT TYPE="submit" VALUE="Login“
               NAME="submit"></td>
   </tr>
   </table>
</FORM>
```

JavaScript

- Goal: Add functionality to the presentation tier.
- Sample applications:
  - Detect browser type and load browser-specific page
  - Form validation - Validate form input fields
  - Browser control - Open new windows, close existing windows (example: pop-up ads)
- Usually embedded directly inside the HTML with the **`<SCRIPT>`** … **`</SCRIPT>`** tag.
- **`<SCRIPT>`** tag has several attributes:
  - **`LANGUAGE`** - specifies language of the script (such as javascript)
  - **`SRC`** - external file with script code
  - Example:

```
<SCRIPT LANGUAGE="JavaScript" SRC="validate.js>
</SCRIPT>
```

JavaScript (Contd.)

- If **`<SCRIPT>`** tag does not have a SRC attribute, then the JavaScript is directly in the HTML file
- Example:

```
<SCRIPT LANGUAGE=“JavaScript”>
<!-- alert(“Welcome to our bookstore”)
//-->
</SCRIPT>
```

- Two different commenting styles
  - Single line comments : **`<!--`** comment for HTML, since the following JavaScript code should be ignored by the HTML processor and **`//`** comment for JavaScript in order to end the HTML comment
  - Multi-line comments : **`/*`** to start and **`*/`** to end comment

JavaScript (Contd.)

JavaScript is a complete scripting language

- Variables
- Assignments (=, +=, …)
- Comparison operators (<,>,…), boolean operators (&&, | |, !)
- Statements
  - if (condition) {statements;} else {statements;}
  - for loops, do-while loops, and while-loops
- Functions with return values
  - Create functions using the **`function`** keyword
  - **`function foo(arg1, …, argk) {statements;}`**

JavaScript: A Complete Example

HTML Form:

```
<form name=“LoginForm” method="POST“
 action="TableOfContents.jsp“
 onSubmit=“return testLoginEmpty()”>
 <input type="text" name="userid">
 <input type="password"
   name="password">
 <input type="submit" value="Login“
   name="submit">
 <input type=“reset” value=“Clear”>
</form>
```

Associated JavaScript:

```
<script language="javascript">
function testLoginEmpty()
{
  loginForm = document.LoginForm
  if ((loginForm.userid.value == "") ||
      (loginForm.password.value == ""))
  {
    alert('Please enter values for userid
   and password.');
    return false;
  }
  else return true;
}
</script>
```

Stylesheets

- ***Goal:*** Separate display from contents, and adapt display to different presentation formats
- Two aspects:
  - Document **transformations** to decide what parts of the document to display in what order
  - Document **rending** to decide how each part of the document is displayed
- **Why** use stylesheets?
  - Reuse of the same document for different displays
  - Tailor display to user's preferences
  - Reuse of the same document in different contexts
  - `http://www.csszengarden.com/`
- Two stylesheet languages
  - **Cascading style sheets (CSS)** - For **HTML** documents
  - **Extensible stylesheet language (XSL)** - For **XML** documents

CSS: Cascading Style Sheets

- Defines **how** to display HTML documents
- **Many** HTML documents can refer to the **same CSS**
  - Can **change format of a website** by changing a **single** style sheet
  - Example:
    ```
    <LINK REL="style sheet" TYPE="text/css"
    HREF="books.css"/>
    ```

Each line consists of **three parts**:

```
selector {property: value}
```

- **`selector`** - Tag whose format is defined
- **`property`** - Tag's attribute whose value is set
- **`value`** - value of the attribute

CSS: Cascading Style Sheets

Example style sheet:

```
body {background-color: yellow}
h1 {font-size: 36pt}
h3 {color: blue}
p {margin-left: 50px; color: red}
```

The first line has the same effect as:

```
  <body background-color=“yellow>
```

XSL

- Language for expressing style sheets in XML
  - More at: http://www.w3.org/Style/XSL/

- Three components
  - XSLT - **XSL Transformation language**
    - Can transform one document to another
    - More at http://www.w3.org/TR/xslt
  - XPath - **XML Path Language**
    - Selects parts of an XML document
    - More at http://www.w3.org/TR/xpath
  - XSL - **Formatting Objects**
    - Formats the output of an XSL transformation
    - More at http://www.w3.org/TR/xsl/

Lecture Overview

- Internet Concepts
- Web data formats
  - HTML, XML, DTDs
- Introduction to three-tier architectures
- The presentation layer
  - HTML forms; HTTP Get and POST, URL encoding; Javascript; Stylesheets. XSLT
- **The middle tier**
  - **CGI, application servers, Servlets, JavaServerPages, passing arguments, maintaining state (cookies)**

Overview of the Middle Tier

- **Recall: Functionality of the middle tier**
  - Encodes **business logic**
  - **Connects** to database system(s)
  - **Accepts form input** from the **presentation tier**
  - Generates **output** for the **presentation tier**
- We will cover
  - **CGI** - Protocol for passing arguments to programs running at the middle tier
  - **Application servers** - Runtime environment at the middle tier
  - **Servlets** - Java programs at the middle tier
  - **JavaServerPages** - Java scripts at the middle tier
  - **Maintaining state** - How to maintain state at the middle tier. Main focus: **Cookies**

CGI: Common Gateway Interface

- ***Goal:*** Transmit arguments from HTML forms to application programs running at the middle tier
- Details of the actual CGI protocol unimportant
  - libraries implement high-level interfaces

- Disadvantages:
  - The application program is invoked in a **new process** at **every invocation** (remedy: **FastCGI**)
  - **No resource sharing** between application programs (e.g., database connections)
  - Remedy: **Application servers**

CGI: Example

- HTML form:

```
<form action=“findbooks.cgi” method=POST>
Type an author name:
<input type=“text” name=“authorName”>
<input type=“submit” value=“Send it”>
<input type=“reset” value=“Clear form”>
</form>
```

- Perl code (fig 7.16, p253):

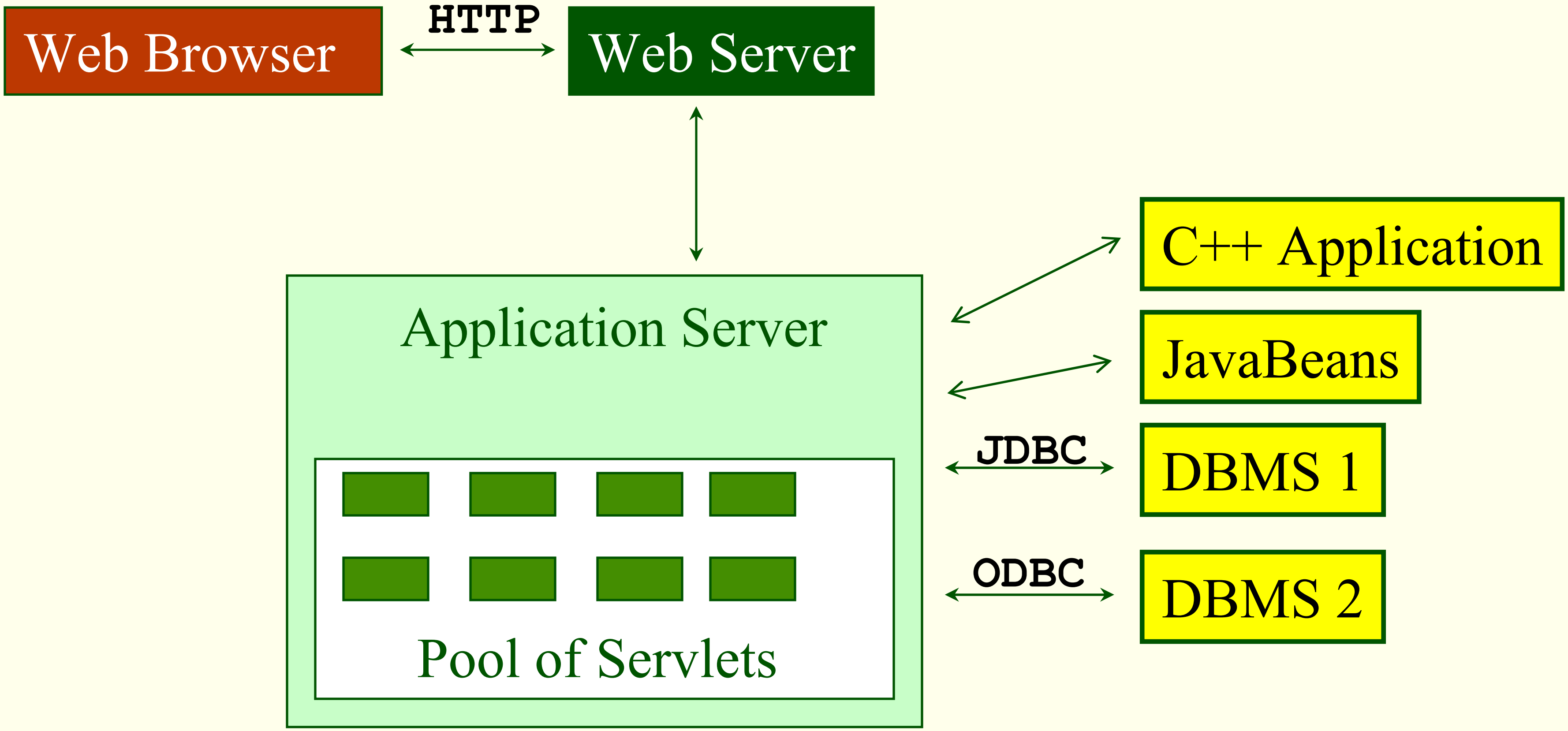
```
use CGI;
$dataIn=new CGI;
$dataIn->header();
$authorName=$dataIn->param(‘authorName’);
print(“<HTML><TITLE>Argument passing test</TITLE>”);
print(“The author name is “ + $authorName);
print(“</HTML>”);
exit;
```

Application Servers

- ***Idea*: Avoid the overhead of CGI**
  - Main **pool of threads** of processes
  - **Manage** connections
  - Enable access to **heterogeneous data sources**
  - **Other functionality** such as APIs for **session management**

Application Server: Process Structure

Process Structure



Servlets

- **Java Servlets** - Java code that runs on the middle tier
  - Platform independent
  - Complete Java API available, including JDBC

Example:

```
import java.io.*;
import java.servlet.*;
import java.servlet.http.*;

public class ServetTemplate extends HttpServlet {
   public void doGet(HTTPServletRequest request,
                              HTTPServletResponse response)
   throws SerletExpection, IOException {
        PrintWriter out=response.getWriter();
        out.println(“Hello World”);
   }
}
```

Servlets (Contd.)

- The **Life of a Servlet:**
  - Webserver forwards request to **servlet container**
  - Container creates **servlet instance** (calls **`init()`** method; deallocation time: calls **`destroy()`** method)
  - Container calls **`service()`** method
    - **`service()`** calls **`doGet()`** for HTTP GET or **`doPost()`** for HTTP POST

Servlets: A Complete Example

```
public class ReadUserName extends HttpServlet {
   public void doGet(  HttpServletRequest request,
                       HttpSevletResponse response)
        throws ServletException, IOException {
        reponse.setContentType(“text/html”);
        PrintWriter out=response.getWriter();
        out.println(“<HTML><BODY>\n <UL> \n” +
               “<LI>” + request.getParameter(“userid”) + “\n” +
               “<LI>” + request.getParameter(“password”) + “\n” +
               “<UL>\n<BODY></HTML>”);
   }
   public void doPost( HttpServletRequest request,
                       HttpSevletResponse response)
        throws ServletException, IOException {
        doGet(request,response);
   }
}
```

Java Server Pages

- **Servlets**
  - Generate HTML by writing it to the "PrintWriter" object
  - Code first, webpage second
- **JavaServerPages**
  - Written in **HTML**, Servlet-like code **embedded** in the HTML
  - Webpage first, code second
  - They are usually compiled into a Servlet

JavaServerPages: Example

```
<html>
<head><title>Welcome to B&N</title></head>
<body>
  <h1>Welcome back!</h1>
  <% String name=“NewUser”;
      if (request.getParameter(“username”) !=
  null) {

      name=request.getParameter(“username”);
      }
  %>
  You are logged on as user <%=name%>
  <p>
</body>
</html>
```

Maintaining State

HTTP is **stateless**!

- Advantages
  - **Easy** to use: don't need anything
  - **Great** for **static-information** applications
  - Requires **no extra memory space**
- Disadvantages
  - **No record** of what **previous** request means
    - No shopping baskets
    - No user logins
    - No custom or dynamic content
    - Security is more difficult to implement

Application State

- **Server-side state**
  - Information is **stored** in a **database**, or in the **application layer's** local **memory**
- **Client-side state**
  - Information is stored on the **client's computer** in the form of a **cookie**
- **Hidden state**
  - Information is hidden within dynamically created web pages

Application State

So many kinds of state…

…how will I choose?

Server-Side State

- Many types of Server side state:
- 1. **Store information in a database**
  - Data will be safe in the database
  - BUT: requires a database access to query or update the information
- 2. **Use application layer's local memory**
  - Can map the user's IP address to some state
  - BUT: this information is volatile and takes up lots of server main memory

Server-Side State

- Should **use** Server-side state maintenance **for information that needs to persist**
  - Old customer orders
  - "Click trails" of a user's movement through a site
  - Permanent choices a user makes

Client-side State: Cookies

- Storing text on the client which will be **passed** to the application with **every HTTP request**
  - Can be **disabled by the client**.
  - Are wrongfully **perceived as "dangerous",** and therefore will scare away potential site visitors if asked to enable cookies
- Are a **collection** of (name, value) pairs

[1]http://www.webdevelopersjournal.com/columns/stateful.html

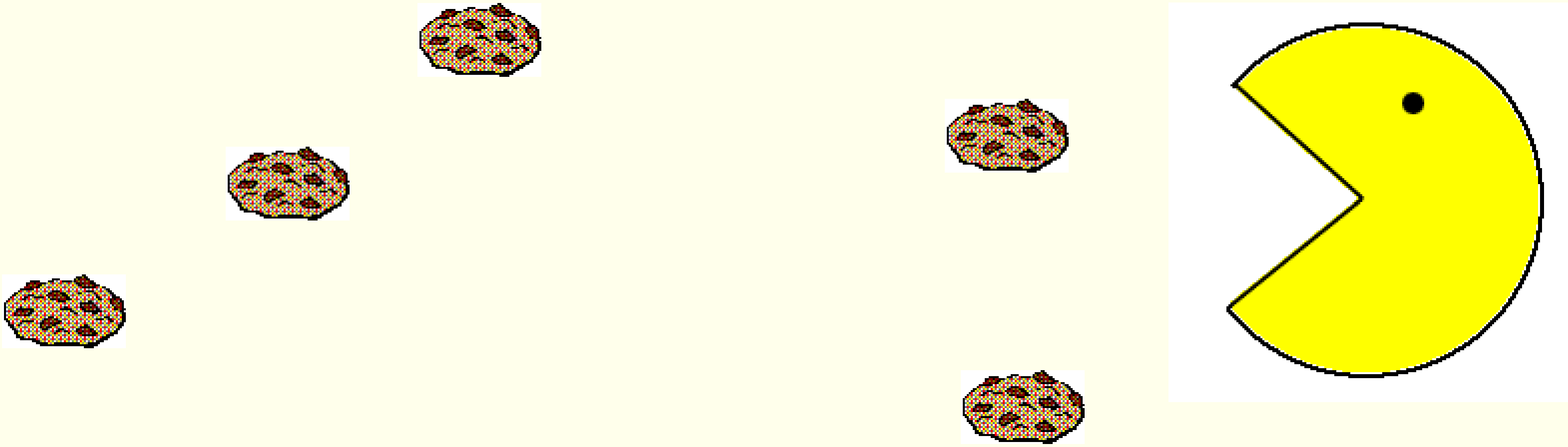
Client State: Cookies

- ***Advantages***
  - Easy to use in Java Servlets / JSP
  - Provide a simple way to persist non-essential data on the client even when the browser has closed
- ***Disadvantages***
  - Limit of 4 kilobytes of information
  - Users can (and often will) disable them
- Should use cookies to **store interactive state**
  - The current user's login information
  - The current shopping basket
  - Any **non-permanent choices** the user has made

Creating A Cookie

```
Cookie myCookie =
  new Cookie(“username", “jeffd");
response.addCookie(userCookie);
```

- You can create a cookie at any time



Accessing A Cookie’s Contents

```
Cookie[] cookies = request.getCookies();
String theUser;
for(int i=0; i<cookies.length; i++) {
  Cookie cookie = cookies[i];
  if(cookie.getName().equals(“username”))
      theUser = cookie.getValue();
}
// at this point theUser == “username”
```

Cookie Features

- Cookies can have
  - A **duration** (expire right away or persist even after the browser has closed)
  - **Filters** for which domains/directory paths the cookie is sent to
- See the Java Servlet API and Servlet Tutorials for more information

Hidden State

- Often **users will disable** cookies
- You can "**hide**" data in two places:
  - Hidden fields **within a form**
  - Using the **path information**
- Requires no "storage" of information because the state information is passed inside of each web page

Hidden State: Hidden Fields

- Declare hidden fields within a form:
  - `<input type=‘hidden’ name=‘user’ value=‘username’/>`
- Users will not see this information (unless they **view** the **HTML source**)
- If used prolifically, it’s a **killer for performance** since EVERY page must be contained within a form

Hidden State: Path Information

- Path information is **stored in the URL** request:

`http://server.com/index.htm?user=jeffd`

- Can separate ‘fields’ with an & character:

`index.htm?user=jeffd&preference=pepsi`

- There are mechanisms to parse this field in Java. Check out the `javax.servlet.http.HttpUtils` `parserQueryString()` method.

Multiple state methods

- **Typically** all methods of state maintenance are used:
  - **User logs in** and this information is stored in a **cookie**
  - User issues a **query** which is **stored in the path information**
  - User places an item in a **shopping basket cookie**
  - User **purchases items** and **credit-card** information is **stored/retrieved from a database**
  - User leaves a **click-stream** which is kept in a **log** on the web server (which can later be analyzed)

Summary

We covered:

- Internet Concepts (URIs, HTTP)
- Web data formats
  - HTML, XML, DTDs
- Three-tier architectures
- The presentation layer
  - HTML forms; HTTP Get and POST, URL encoding; Javascript; Stylesheets. XSLT
- The middle tier
  - CGI, application servers, Servlets, JavaServerPages, passing arguments, maintaining state (cookies)

Useful Websites

- http://www.webdeveloper.com/ - a very good web forum with lots of stuff
- http://www.csszengarden.com/ – css Zen Garden
- http://www.xml.org/ - everything you ever wanted to know about XML
- http://www.w3.org/Style/XSL/ - definitive source for XSL

Homework

- Read Chapter Seven