Web Programming Step by Step

Lecture 20
XML
Reading: 10.3 - 10.4

What is XML?

- **XML**: a "skeleton" for creating markup languages
- you already know it!
  - syntax is identical to XHTML's:

```
<element attribute="value">content</element>                XML
```

- languages written in XML specify:
  - names of tags   in XHTML: `h1`, `div`, `img`, etc.
  - names of attributes   in XHTML: `id`/`class`, `src`, `href`, etc.
  - rules about how they go together   in XHTML: inline vs. block-level elements
- used to present complex data in human-readable form
  - "self-describing data"

Anatomy of an XML file

```xml
<?xml version="1.0" encoding="UTF-8"?>   <!-- XML prolog -->
<note>   <!-- root element -->
  <to>Tove</to>
  <from>Jani</from>   <!-- element ("tag") -->
  <subject>Reminder</subject>   <!-- content of element -->
  <message language="english">   <!-- attribute and its value -->
    Don't forget me this weekend!
  </message>
</note>
```

- begins with an `<?xml ... ?>` header tag ("**prolog**")
- has a single **root element** (in this case, `note`)
- tag, attribute, and comment syntax is just like XHTML

Uses of XML

- XML data comes from many sources on the web:
  - **web servers** store data as XML files
  - **databases** sometimes return query results as XML
  - **web services** use XML to communicate
- XML is the *de facto* universal format for exchange of data
- XML languages are used for music, math, vector graphics
- popular use: RSS for news feeds & podcasts

Pros and cons of XML

pro:

- easy to read (for humans and computers)
- standard format makes automation easy
- don't have to "reinvent the wheel" for storing new types of data
- international, platform-independent, open/free standard
- can represent almost any general kind of data (record, list, tree)

con:

- bulky syntax/structure makes files large; can decrease performance
  - example: quadratic formula in MathML
- can be hard to "shoehorn" data into a good XML format

What tags are legal in XML?

- *any tags you want!*
- examples:
  - an email message might use tags called `to`, `from`, `subject`
  - a library might use tags called `book`, `title`, `author`
- when designing an XML file, *you* choose the tags and attributes that best represent the data
- rule of thumb: data = tag, metadata = attribute

Doctypes and Schemas

- "rule books" for individual flavors of XML
  - list which tags and attributes are valid in that language, and how they can be used together
- used to *validate* XML files to make sure they follow the rules of that "flavor"
  - the W3C HTML validator uses the XHTML doctype to validate your HTML
- for more info:
  - Document Type Definition (DTD) ("doctype")
  - W3C XML Schema
- optional — if you don't have one, there are no rules beyond having well-formed XML syntax
- (we won't cover these any further here)

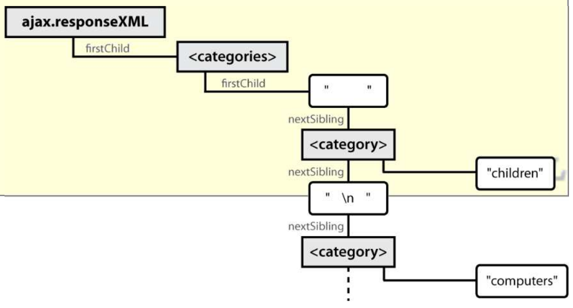
XML and Ajax

- web browsers can display XML files, but often you instead want to fetch one and analyze its data
- the XML data is fetched, processed, and displayed using Ajax
  - (XML is the "X" in "Ajax")

- It would be very clunky to examine a complex XML structure as just a giant string!
- luckily, the browser can break apart (**parse**) XML data into a set of objects
  - there is an XML DOM, very similar to the (X)HTML DOM

XML DOM tree structure

```
<?xml version="1.0" encoding="UTF-8"?>
<categories>
  <category>children</category>
  <category>computers</category>
  ...
</categories>
```



- the XML tags have a tree structure
- DOM nodes have parents, children, and siblings

Recall: Javascript XML (XHTML) DOM

The DOM properties and methods* we already know can be used on XML nodes:

- properties:
  - `firstChild`, `lastChild`, `childNodes`, `nextSibling`, `previousSibling`, `parentNode`
  - **`nodeName`**, **`nodeType`**, **`nodeValue`**, **`attributes`**
- methods:
  - `appendChild`, `insertBefore`, `removeChild`, `replaceChild`
  - **`getElementsByTagName`**, **`getAttribute`**, **`hasAttributes`**, **`hasChildNodes`**
- caution: cannot use HTML-specific properties like `innerHTML` in the XML DOM!

* (though not Prototype's, such as `up`, `down`, `ancestors`, `childElements`, `descendants`, or `siblings`)

Navigating the node tree

- caution: can *only* use standard DOM methods and properties in XML DOM
  - HTML DOM has Prototype methods, but XML DOM **does not!** (o noes!)
- caution: can't use `id`s or `class`es to use to get specific nodes
  - `id` and `class` are not necessarily defined as attributes in the flavor of XML being read
- caution: `firstChild`/`nextSibling` properties are unreliable
  - annoying whitespace text nodes!
- the best way to walk the XML tree:

```
var elms = node.getElementsByTagName("tagName")
```

  - returns an **array** of all *node*'s children of the given tag name

```
node.getAttribute("attributeName")
```

  - gets an attribute of an element

Using XML data in a web page

Procedure:

1. use Ajax to fetch data
2. use DOM methods to examine XML:
   - *XMLnode*`.getElementsByTagName()`
3. extract the data we need from the XML:
   - *XMLelement*`.getAttribute()`, *XMLelement*`.firstChild.nodeValue`, etc.
4. create new HTML nodes and populate with extracted data:
   - `document.createElement()`, *HTMLelement*`.innerHTML`
5. inject newly-created HTML nodes into page
   - *HTMLelement*`.appendChild()`

Fetching XML using AJAX (template)

```
  new Ajax.Request(
    "url",
    {
      method: "get",
      onSuccess: functionName
    }
  );
  ...

function functionName(ajax) {
  do something with ajax.responseXML;
}
```
JS

- `ajax.responseText` contains the XML data in plain text
- `ajax.responseXML` is a pre-parsed XML DOM object

Analyzing a fetched XML file using DOM

```
<?xml version="1.0" encoding="UTF-8"?>
<foo bloop="bleep">
  <bar/>
  <baz><quux/></baz>
  <baz><xyzzy/></baz>
</foo>
```
XML

We can use DOM properties and methods on `ajax.responseXML`:

```
// zeroth element of array of length 1
var foo = ajax.responseXML.getElementsByTagName("foo")[0];

// ditto
var bar = foo.getElementsByTagName("bar")[0];

// array of length 2
var all_bazzes = foo.getElementsByTagName("baz");

// string "bleep"
var bloop = foo.getAttribute("bloop");
```
JS

Exercise: Late day distribution

- Write a program that shows how many students turn homework in late for each assignment.
- Data service here: `http://webster.cs.washington.edu/hw/`
    - parameter: `assignment=hw`*`n`*

Recall: Pitfalls of the DOM

```xml
<?xml version="1.0" encoding="UTF-8"?>
<foo bloop="bleep">
  <bar/>
  <baz><quux/></baz>
  <baz><xyzzy/></baz>
</foo>
```

We are reminded of some pitfalls of the DOM:

```js
// works - XML prolog is removed from document tree
var foo = ajax.responseXML.firstChild;

// WRONG - just a text node with whitespace!
var bar = foo.firstChild;

// works
var first_baz = foo.getElementsByTagName("baz")[0];

// WRONG - just a text node with whitespace!
var second_baz = first_baz.nextSibling;

// works - why?
var xyzzy = second_baz.firstChild;
```

Larger XML file example

```xml
<?xml version="1.0" encoding="UTF-8"?>
<bookstore>
  <book category="cooking">
    <title lang="en">Everyday Italian</title>
    <author>Giada De Laurentiis</author>
    <year>2005</year><price>30.00</price>
  </book>
  <book category="computers">
    <title lang="en">XQuery Kick Start</title>
    <author>James McGovern</author>
    <year>2003</year><price>49.99</price>
  </book>
  <book category="children">
    <title lang="en">Harry Potter</title>
    <author>J K. Rowling</author>
    <year>2005</year><price>29.99</price>
  </book>
  <book category="computers">
    <title lang="en">Learning XML</title>
    <author>Erik T. Ray</author>
    <year>2003</year><price>39.95</price>
  </book>
</bookstore>
```

Navigating node tree example

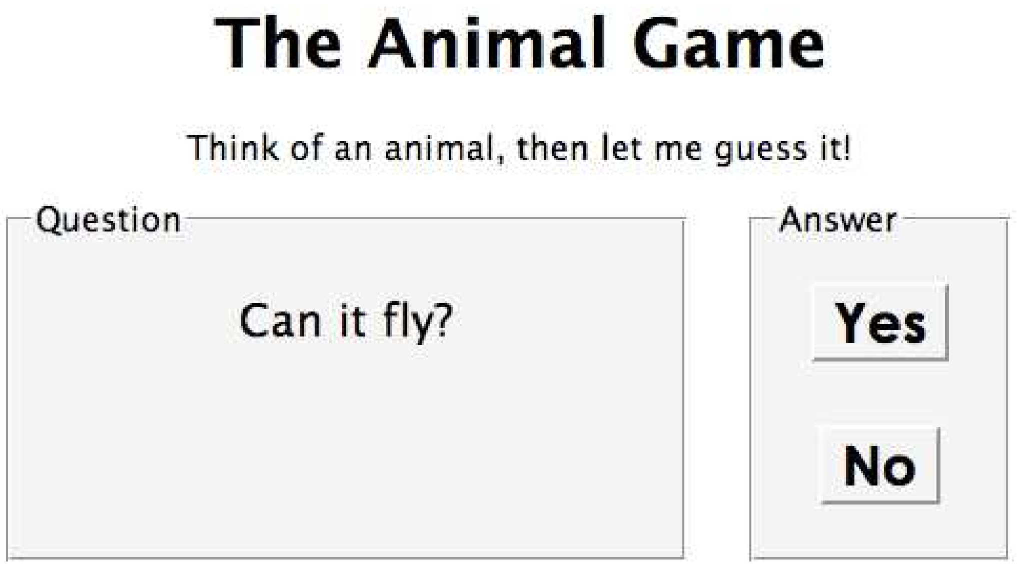
```js
// make a paragraph for each book about computers
var books = ajax.responseXML.getElementsByTagName("book");
for (var i = 0; i < books.length; i++) {
  var category = books[i].getAttribute("category");
  if (category == "computers") {
    // extract data from XML
    var title = books[i].getElementsByTagName("title")[0].firstChild.nodeValue;
    var author = books[i].getElementsByTagName("author")[0].firstChild.nodeValu

    // make an XHTML <p> tag containing data from XML
    var p = document.createElement("p");
    p.innerHTML = title + ", by " + author;
    document.body.appendChild(p);
  }
}
```

A historical interlude: why XHTML?

- in XML, different "flavors" can be combined in single document
- theoretical benefit of including other XML data in XHTML
    - nobody does this
- most embedded data are in non-XML formats (e.g., Flash)
    - non-XML data must be embedded another way (we'll talk about this later on)
- requires browser/plugin support for other "flavor" of XML
    - development slow to nonexistent
    - most XML flavors are specialized uses

Exercise: Animal game

- Write a program that guesses which animal the user is thinking of. The program will arrive at a guess based on the user's responses to yes or no questions. The questions come from a web app named `animalgame.php`.



Practice problem: Animal game (cont'd)

- The data comes in the following format:

```xml
<node nodeid="id">
  <question>question</question>
  <yes nodeid="id" />

  <no nodeid="id" />
</node>
```
XML

```xml
<node nodeid="id">
  <answer>answer</answer>

</node>
```
XML

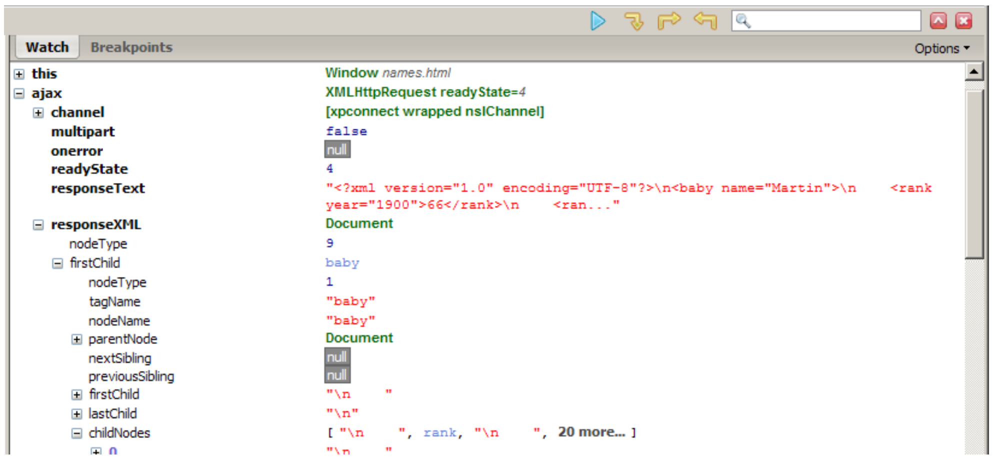
- to get a node with a given id: `animalgame.php?nodeid=`*id*
- start by requesting the node with `nodeid` of `1` to get the first question

Attacking the problem

Questions we should ask ourselves:

- How do I retrieve data from the web app? (what URL, etc.)
- Once I retrieve a piece of data, what should I do with it?
- When the user clicks "Yes", what should I do?
- When the user clicks "No", what should I do?
- How do I know when the game is over? What should I do in this case?

Debugging `responseXML` in Firebug



```
⊞ this                      Window names.html
⊟ ajax                      XMLHttpRequest readyState=4
  ⊞ channel                 [xpconnect wrapped nsIChannel]
    multipart               false
    onerror                 null
    readyState              4
    responseText            "<?xml version="1.0" encoding="UTF-8"?>\n<baby name="Martin">\n    <rank
                            year="1900">66</rank>\n    <ran..."
  ⊟ responseXML             Document
      nodeType              9
    ⊟ firstChild            baby
        nodeType            1
        tagName             "baby"
        nodeName            "baby"
      ⊞ parentNode          Document
        nextSibling         null
        previousSibling     null
      ⊞ firstChild          "\n    "
      ⊞ lastChild           "\n"
      ⊟ childNodes          [ "\n    ", rank, "\n    ", 20 more... ]
        ⊞ 0                 "\n    "
```

- can examine the entire XML document, its node/tree structure