Ajax Programming

Ray Toal

Loyola Marymount University

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Outline

- What Ajax is
- A few demos
- First steps programming an Ajax application
- Real programming: JavaScript doesn't suck
- Design patterns and libraries
- Where to learn more

What this talk is about

- What Ajax is, or means, for those who don't know (Hands, please? Anyone?)
- Why Ajax matters
- Serious programming in JavaScript
- Distributed programming (remoting) in general, because there are alternatives to Ajax

What this talk is not about

- Novice JavaScript-ing
- Stupid DHTML tricks
- Web Services
- Whether or not Ajax sux/rox/blows/...
- How to use Backbase or Echo2 or ...
- Jesse James Garrett

In case you didn't know

- Ajax is a snappy term given (last year) to a collection of technologies that have been around since the previous century
- Ajax stands for Asynchronous Javascript And XML
- The XML part isn't required... plain text and JSON are often used instead, but Ajat and Ajaj sound stupid

Why Ajaxify?

- Because many web applications in which every action causes the whole freakin' page to refresh are annoying
- Because you can create rich client applications without users installing the applications
- Because the techniques are (1) cross-browser, (2) server technology-agnostic, (3) require no plugins, and (4) mostly use open standards !

DEMO TIME !!!

- Google Maps http://maps.google.com
- Google Suggest http://www.google.com/webhp?complete=1
- Rico Demos http://openrico.org/rico/demos.page
- ajaxpattens.org Demos http://www.ajaxify.com/run/
- script.aculo.us Demos http://wiki.script.aculo.us/scriptaculous/show/Demos

What was behind those demos?

- Two basic things:
  1. The actual document object in the browser was being modified dynamically (those were not Flash movies, applets, or other plugins)
  2. The browser was making asynchronous requests and processing the server's responses (again, without the full page refresh)

Now do it yourself

```
<html>
  <head>
    <title>Gettin stairtit wi Ajax</title>
    <script type="text/javascript" src="basicajax.js"></script>
  </head>

  <body>
    <p>Whit's the
    <a href="javascript:fetchText('services/now.jsp', 'x')">time</a>?
    <span id="x"></span>.  Thenk ye.  Fare ye weel.</p>
  </body>
</html>
```

And the script...

```
function createXMLHttpRequest() {
    try {return new ActiveXObject("Msxml2.XMLHTTP");} catch (e) {}
    try {return new ActiveXObject("Microsoft.XMLHTTP");} catch (e) {}
    try {return new XMLHttpRequest();} catch(e) {}
    return null;
}

function fetchText(url, id) {
    var xmlhttp = createXMLHttpRequest();
    xmlhttp.onreadystatechange = function() {
        if (xmlhttp.readyState == 4 && xmlhttp.status == 200) {
            document.getElementById(id).innerHTML = xmlhttp.responseText;
        }
    };
    xmlhttp.open('GET', url);
    xmlhttp.send(null);
}
```

Four defining principles of Ajax

- The browser hosts an application, not content
- The server delivers data, not content
- User interaction can be fluid and continuous
- This is real coding and requires discipline

from David Crane and Eric Pascarello,
Ajax in Action, Manning, 2006

Ajax programmers gotta know...

- HTTP, at least the basics
- XML and XHTML
- The DOM
- CSS
- JavaScript, really, really well

So let's spend some time on JavaScript...

JavaScript

- Small, elegant, very expressive, very powerful
- Flexible, dynamic (it's got eval)
- Closest to Lisp, nothing at all like Java
- OO done with prototypes, not classes
- "World's most misunderstood programming language"
- Based on ECMA-262 international standard

JavaScript programming

- Like all good scripting languages, not much boilerplate — just start coding:

```
document.write("<b>Some cubes for " + today() + "</b>");
function today() {
    return new Date();
}
var n = 10;
for (i = 0; i < n; i++) {
    document.write("<br />" + cubed(i));
}
function cubed(x) {
    return x * x * x;
}
```

JavaScript data types

- There are only six
  - Undefined: only value is undefined
  - Null: only value is null
  - Boolean: only values are true and false
  - Number: e.g., 3, -9.872E31, 0x4C, NaN
  - String: e.g., "Hello", "Ol\u00e9"
  - Object: everything else

JavaScript objects

- Don't declare classes — just create objects and add properties on the fly:

```
var x = new Object();
x.age = 17;
x.height = 65.3;
var y = x.age + x["height"];
var z = {age: 30, color: "red", total: 3};
var cool = {triple: {a: 4, b: undefined, c: {4: null}}, 7: "stuff"};

function midpoint(p, q) {
    return {x: (p.x+q.x)/2, y: (p.y+q.y)/2}
}
```

JavaScript arrays

- Arrays are just objects with properties that are integers:

```
var a = new Array();
a[0] = 5 * a[i];
var b = new Array(10);  // initialized with 10 cells
var c = new Array(1, 5, 25); // initialized with 3 cells
var d = [1, 5, 25];
var e = [1, true, [1,2], {x:5, y:6}, "Hi"];
var f = {triple: {a:4, b:"dog", c:[1,null]}, 7: "stuff"};
var g = [f.triple.a, f[7]];
var y = a.length;
```

JavaScript functions

- A function is just an object. Three examples:

```
function successor(x) {return x + 1;}
var sum = function(x,y) {return x + y;}
var predecessor = new Function("x", "return x - 1;");      // slow
```

- Since a function is just an object it can
  - have properties that are other objects
  - be a property of another object (in which case it is called a method) — whoa, sounds like OOP...
  - be passed as an argument to another function
  - be returned as a value from another function

More JavaScript functions

- Functional programming rocks

```
function plusSix (x) {return x + 6;}
function squared (x) {return x * x;}
function twice (f, x) {return f(f(x));}
assert(twice(plusSix, 5) == 17);
assert(twice(squared, 4) == 256);
function compose (f, g) {return function(x) {return g(f(x));}}
var squareThenPlusSix = compose(squared, plusSix);
assert(squareThenPlusSix(10) == 106);
assert(compose(plusSix, squared)(5) == 121);
document.write("twice expects " + twice.length + " arguments");
```

this

- If you call a function that is a property of an object, then within that function the expression "this" refers to the containing object.

```
var x = {a: 1, b: function(x) {return x + this.a;}};
document.write(x.b(2));                                    // writes 3
```

- "this" is evaluated dynamically, not statically:

```
function f(x) {return x + this.a;}
var x = {a: 10, b: f};
document.write(x.b(2));                                    // writes 12
```

new

- Prefixing a function call with "new" makes "this" refer to a new object instead:

```
function Point() {
    this.x = 0;
    this.y = 0;
    this.move = function(dx, dy) {this.x += dx; this.y += dy;}
    this.reflect = function() {this.x = -this.x; this.y = -this.y;}
};

var p = new Point();                    // Note the use of "new"
p.move(52, 40);
p.reflect();
document.write(p.x + " " + p.y);        // writes 12
```

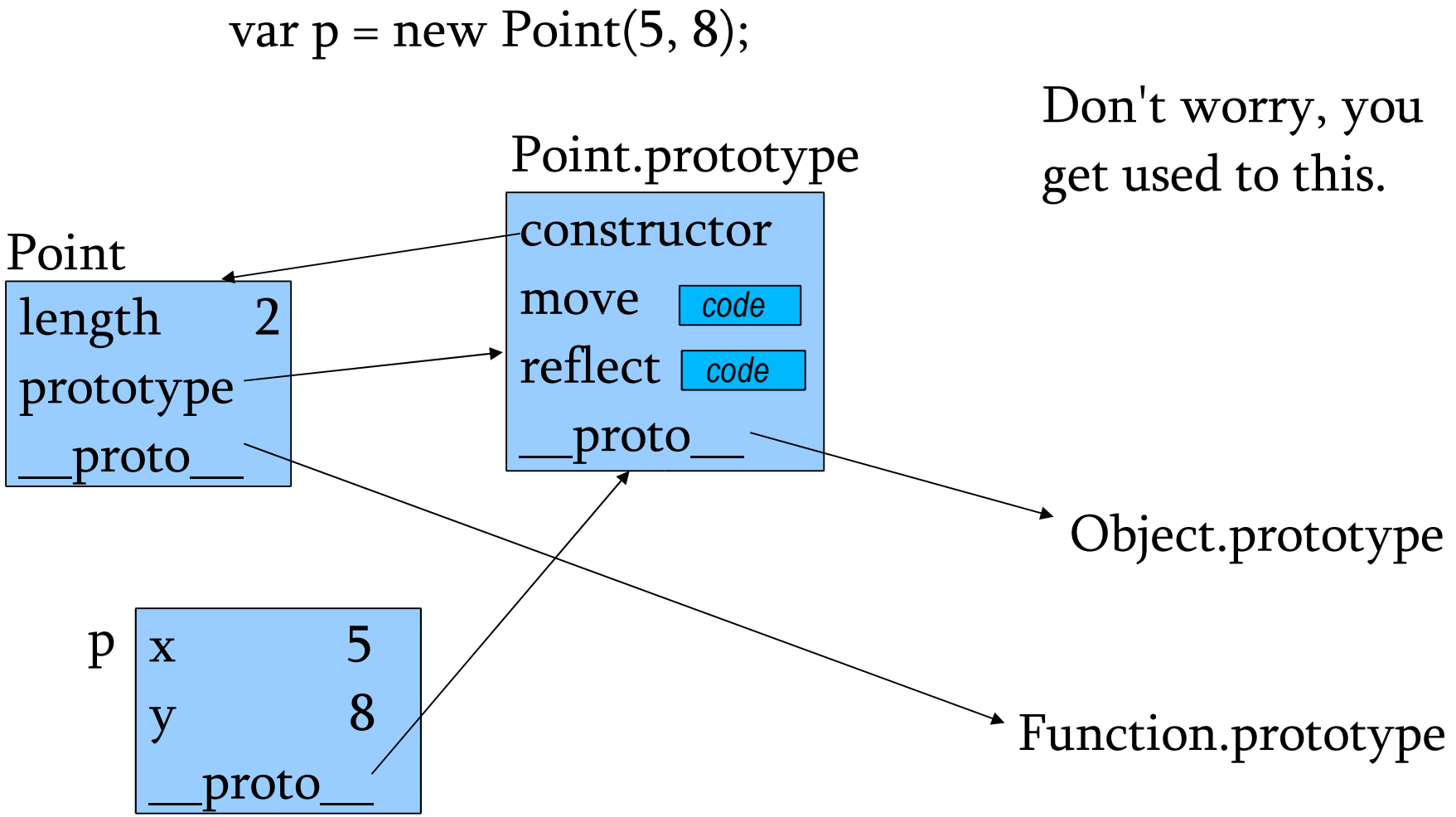
Prototypes

- Oops, the code on the last slide sucked! Each new point gets a copy of the move and reflect functions. Here is the right way:

```
function Point(x, y) {
    this.x = x || 0;
    this.y = y || 0;
};
Point.prototype.move = function(dx, dy) {this.x += dx; this.y += dy;}
Point.prototype.reflect = function() {this.x = -this.x; this.y = -this.y;}
```

- Also note the cool "default parameters" here.

Constructors, prototypes, instances



Built-in JavaScript objects

Object Object.prototype Function Function.prototype Array Array.prototype String String.prototype Boolean Boolean.prototype Number Number.prototype Math Date Date.prototype RegExp RegExp.prototype Error Error.prototype ...

Navigator Document Window Location Screen Event History

Anchor Area Applet Base Basefont Body Button Checkbox FileUpload Form Frame Frameset Hidden Iframe Image Link Meta Option Password Radio Reset Select Style Submit Table TableData TableHeader TableRow Text TextArea XMLHttpRequest

There's also a "global" object you don't refer to directly: its properties (e.g. eval, parseInt, decodeURI, Infinity, NaN, etc.) are used w/o qualification

XMLHttpRequest properties

onreadystatechange	the callback
readystate	(see next slide)
open(method, url, async)	connect
setRequestHeader(key, value)	
send(content)	
responseText	
responseXML	already parsed for you!
status	200 or 403 or 404 or ...
statusText	"OK" or "Forbidden" or ...
getResponseHeader(key)	
getAllResponseHeaders()	returns a big ugly string
abort()	

Ready states

0 = uninitialized
1 = loading
2 = loaded
3 = interactive
4 = complete

Every time the ready state changes, your callback is called

Passing request parameters

- This is just one way (simple, not the best):

```
<form onsubmit="javascript:postAndFetchText(
    'services/temperature_converter.jsp',
    'value=' + document.getElementById('value').value
    + '&units=' + document.getElementById('units').value,
    'result'); return false;">
    <input id="value" width="20" />
    <select id="units">
        <option>F</option><option>C</option><option>K</option>
    </select>
    <input type="submit" value="Convert" />
</form>
```

Form parameters

```
function postAndFetchText(url, content, id) {
    var xmlhttp = createXMLHttpRequest();
    xmlhttp.onreadystatechange = function() {
        if (xmlhttp.readyState == 4 && xmlhttp.status == 200) {
            document.getElementById(id).innerHTML =
                xmlhttp.responseText;
        }
    };
    xmlhttp.open('POST', url);
    xmlhttp.setRequestHeader("Content-Type",
        "application/x-www-form-urlencoded");
    xmlhttp.send(content);
}
```

Getting XML back

- Suppose our temperature converter replies with things like this:
  - <error>Units must be c, k, or f</error>
  - <error>Bad temperature: 34fesf42</error>
  - <data><c>5</c><f>41</f><k>278.15</k></data>
- The responseXML property will contain a XML tree; navigate this the usual way
- We'll want to set a CSS style for the response based on the root element.

Passing off the XML

```
function postAndFetchXml(url, content, handler) {
    var xmlhttp = createXMLHttpRequest();
    xmlhttp.onreadystatechange = function() {
        if (xmlhttp.readyState == 4 && xmlhttp.status == 200) {
            handler(xmlhttp.responseXML);
        }
    };
    xmlhttp.open('POST', url);
    xmlhttp.setRequestHeader("Content-Type",
        "application/x-www-form-urlencoded");
    xmlhttp.send(content);
}
```

Handling the XML

```
function temperatureHandler(xmlDoc) {
   var root = xmlDoc.documentElement.nodeName;
   var result = document.getElementById('result');

   if (root == 'error') {
      result.style.color = 'red';
      result.innerHTML = xmlDoc.documentElement.firstChild.nodeValue;
   } else if (root == 'data') { // (this could use some refactoring)
      var k = xmlDoc.getElementsByTagName("k")[0].firstChild.nodeValue;
      var c = xmlDoc.getElementsByTagName("c")[0].firstChild.nodeValue;
      var f = xmlDoc.getElementsByTagName("f")[0].firstChild.nodeValue;
      result.style.color = 'blue';
      result.innerHTML = "<ul><li>" + f + "&deg;F</li><li>" + c
         + "&deg;C</li><li>" + k + " K</li></ul>";
    ...
```

Organizing the application

```
<html>
 <head>
  <title>Temperature Conversion</title>
  <script type="text/javascript" src="basicajax.js"></script>
  <script type="text/javascript" src="temperature.js"></script>
 </head>

 <body>
  <form onsubmit="javascript:postAndFetchXml(
     'services/temperature_converter.jsp',
     'value=' + $('value').value + '&units=' + $('units').value,
     temperatureHandler); return false;">
     Temperature: <input id="value" width="20" />
  ...
```

Library scripts

Application-specfic scripts

Cool function

JSON

- Instead of plain text or XML, have the server send back JSON.... you can eval it directly

```
{"menu": {
    "id": "file",
    "value": "File:",
    "popup": {
        "menuitem": [
            {"value": "New", "onclick": "CreateNewDoc()"},
            {"value": "Open", "onclick": "OpenDoc()"},
            {"value": "Close", "onclick": "CloseDoc()"}
        ]
    }
}}
```

When the application gets big...

- Make "packages"

```
var acme = {
    version: 2.0,
    getReq: function() {...},
    getTextAsync(url, id, params): function {...},
    getXmlDocAsync(url, handler, params): function {...},
    ...
}
```

- There's more: Look online for ways to things like getting the effect of private, static, read-only, inheritance, etc.

This is tedious — help me!!!!

- JavaScript libraries (especially remoting help)
  - prototype, Sarissa, dojo, Mochikit
- Special effects
  - script.aculo.us, Rico, dojo, moo.fx, ...
- Full-scale application frameworks (may or may not make writing JavaScript unnecessary)
  - DWR, Echo2, BackBase, JSON-RPC, Ruby on Rails, Bindows, Atlas, Google Web Toolkit

prototype, the library

- Rico and script.aculo.us are built on prototype, and so are many other libraries and applications.
- Written by Sam Stephenson
- Read about it: http://prototype.conio.net/
- prototype.js is at

  http://prototype.conio.net/dist/prototype-1.4.0.js
- Check out the function called $ (yeeeeeaah)

  $('x') is sorta like document.getElementById('x')

Mochikit

- JavaScript library
- Nice Python-like features (repr, not toString)
- Non-obtrusive (doesn't hack built-ins)
- Has unit tests and documentations
- Makes DOM manipulation easy as innerHTML
- Great event handling (custom events, too)
- Great logging
- Others (higher order fns, iters, dates, async...)
- Not a flashy widget library

dojo

- The standard library JavaScript never had
- Full featured

Custom Widgets
Widget System
UI
Event
Language Utilities
Package System (!)

Design patterns

- Real programmers know design patterns
- A design pattern is a named solution approach to a recurrent problem
- Title, problem, context, solution
- Idea credited to Christopher Alexander
- The GoF popularized them in the world of OOP in 1994 (abstract factory, observer, visitor, builder, state, flyweight, template method, strategy, singleton, ...)

Ajax design patterns

- http://www.ajaxpatterns.org
  - 8 foundational technology patterns
  - 25 programming patterns
  - 28 functionality and usability patterns
  - 8 development practices
- http://developer.yahoo.com/ypatterns
  - Lookup (get data when needed)
  - Persist (real-time saving)
  - Update (visual changes)

Example Patterns

- AJAX Stub
- Call Tracking
- On-demand JavaScript
- XML Data Island
- Submission Throttling
- Multistage Download
- Predictive Fetch
- Cross Domain Proxy

More Example Patterns

- Drilldown
- Microlink
- Live Form
- Live Search
- Progress Indicator
- Suggestion
- Drag and Drop
- Status Area
- Highlight

More On Programming

- Sometimes useful to do class-based inheritance ("classical OOP") in JavaScript
- Example approaches:
  - Iniside Stephenson's prototype library
  - Article on Douglas Crockford's site
  - Dean Edwards's Base
  - Daniel Romano's technique
  - Many others (Fuecks, Lindsey, Daniel, ...)

Romano's Classical Inheritance

```
Function.prototype.extend = function(sub) {
    sub.prototype = new this;
    sub.prototype._super = this;
    sub.prototype.constructor = sub;
    return sub;
}

var Shape = function(c) {this.color = c;}
Shape.prototype.getColor = function() {return this.color;}
var Circle = Shape.extend(function(c, r) {this._super(c); this.radius = r;});
Circle.prototype.getRadius = function() {return this.radius;}
```

Ajax mistakes

- Like many technologies, Ajax is easy to misuse.
- The original "Ajax mistakes" blog post (as far as I know):

  http://alexbosworth.backpackit.com/pub/67688

Let's check it out

- Search "Ajax mistakes" for more (on your own)

Performance

- Probably shouldn't rely on JS interpreter to optimize your code, so you might want to explicitly cache things
- JavaScript memory leaks come from holding on to references too long
  - Cyclic references can be common in Ajax
  - DOM Inspector, modi, Venkman debugger, Mochikit logging, can help

Alternatives to Ajax

- Flash
- IFRAMEs
- Java Applets
- Java WebStart
- XUL
- XAML
- Others?

Article at http://www.ajaxinfo.com/default~viewart~8.htm

Conclusions

- Decent Ajax apps require serious programming
- JavaScript has a lot of power and flexibility many people used to be unaware of
- Lots of toolkits and frameworks out there
- Know some design patterns
- Be aware of common Ajax mistakes
- Know tools: DOM inspector or modi (beta), JS console, debuggers, etc.
- Know some Ajax alternatives