Introduction to Web Programming

Lecture 21: JavaScript Object Notation (JSON)

Pros and cons of XML

- pro:
  - standard open format; don't have to "reinvent the wheel" for storing new types of data
  - can represent almost any general kind of data (record, list, tree)
  - easy to read (for humans and computers)
  - lots of tools exist for working with XML in many languages
- con:
  - bulky syntax/structure makes files large; can decrease performance (example)
  - can be hard to "shoehorn" data into a good XML format
  - JavaScript code to navigate the XML DOM is bulky and generally not fun

An example of XML data

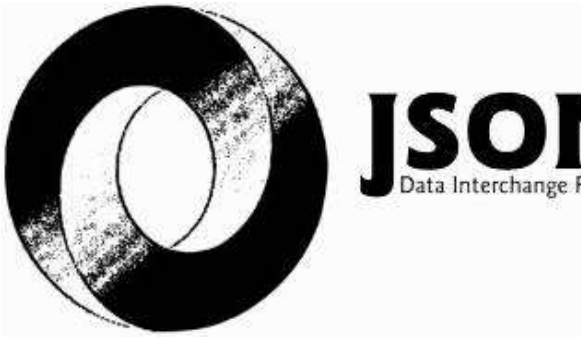
```
<?xml version="1.0" encoding="UTF-8"?>
<note private="true">
  <from>Alice Smith (alice@example.com)</from>
  <to>Robert Jones (roberto@example.com)</to>
  <to>Charles Dodd (cdodd@example.com)</to>
  <subject>Tomorrow's "Birthday Bash" event!</subject>
  <message language="english">
    Hey guys, don't forget to call me this weekend!
  </message>
</note>
```

- fairly simple to read and understand
- can be parsed by JavaScript code using XML DOM
- Is there any other data format that is more natural for JS code to process?

JavaScript Object Notation (JSON)

JavaScript Object Notation (JSON): Data format that represents data as a set of JavaScript objects

- invented by JS guru Douglas Crockford of Yahoo!
- natively supported by all modern browsers (and libraries to support it in old ones)
- not yet as popular as XML, but steadily rising due to its simplicity and ease of use



Background: Creating a new object

```
var name = {
  fieldName: value,
  ...
  fieldName: value
};
```

```
var pt = {
  x: 4,
  y: 3
};
pt.z = -1;
alert("(" + pt.x + ", " + pt.y + ", " + pt.z + ")");   // (4, 3, -1)
```

- in JavaScript, you can create a new object without creating a class
- you can add properties to any object even after it is created (z)

More about JavaScript object syntax

```
var person = {
  name: "Philip J. Fry",                          // string
  age: 23,                                        // number
  "weight": 172.5,                                // number
  friends: ["Farnsworth", "Hermes", "Zoidberg"],  // array
  getBeloved: function() { return this.name + " loves Leela"; }
};
alert(person.age);                                // 23
alert(person["weight"]);                          // 172.5
alert(person.friends[2]));                        // Zoidberg
alert(person.getBeloved());                       // Philip J. Fry loves Leela
```

- an object can have methods (function properties) that refer to itself as `this`
- can refer to the fields with . *fieldName* or `["`*fieldName*`"]` syntax
- field names can optionally be put in quotes (e.g. `weight` above)

Repeated: Example XML data

```
<?xml version="1.0" encoding="UTF-8"?>
<note private="true">
  <from>Alice Smith (alice@example.com)</from>
  <to>Robert Jones (roberto@example.com)</to>
  <to>Charles Dodd (cdodd@example.com)</to>
  <subject>Tomorrow's "Birthday Bash" event!</subject>
  <message language="english">
    Hey guys, don't forget to call me this weekend!
  </message>
</note>
```

- Could we express this message data as a JavaScript object?
- Each attribute and tag could become a property or sub-object within the overall message object

The equivalant JSON data

```
{
  "private": "true",
  "from": "Alice Smith (alice@example.com)",
  "to": [
    "Robert Jones (roberto@example.com)",
    "Charles Dodd (cdodd@example.com)"
  ],
  "subject": "Tomorrow's \"Birthday Bash\" event!",
  "message": {
    "language": "english",
    "text": "Hey guys, don't forget to call me this weekend!"
  }
}
```

Valid JSON

```
var student = {                                 // no variable assignment
  "first_name": 'Bart',                         // strings must be double-quoted
  last_name: "Simpson",                         // property names must be quoted
  "birthdate": new Date("April 1, 1983"),       // Date objects not supported
  "enroll": function() {                        // Functions not supported
    this.enrolled = true;
  }
};
```

- JSON has a few rules that differ from regular JS:
  - Strings must be quoted (in JS, single- or double-quoted are allowed)
  - All property/field names must be quoted
  - Unsupported types: `Function`, `Date`, `RegExp`, `Error`
  - All others supported: `Number`, `String`, `Boolean`, `Array`, `Object`, `null`
- Numerous validators/formatters available: JSONLint, JSON Formatter & Validator, Free Formatter, JSON Validator

Browser JSON methods

method	description
JSON.parse(*string*)	converts the given string of JSON data into an equivalent JavaScript object and returns it
JSON.stringify(*object*)	converts the given object into a string of JSON data (the opposite of JSON.parse)

- you can use Ajax to fetch data that is in JSON format
- then call JSON.parse on it to convert it into an object
- then interact with that object as you would with any other JavaScript object

JSON expressions exercise

Given the JSON data at right, what expressions would produce:

- The window's title? *(use the Console)*
- The image's third coordinate?
- The number of messages?
- The y-offset of the last message?

```
var title = data.window.title;
var coord = data.image.coords[2];
var len = data.messages.length;
var y = data.messages[len - 1].offset[1];
```

```
var data = JSON.parse(this.responseText
```

```
{
  "window": {
    "title": "Sample Widget",
    "width": 500,
    "height": 500
  },
  "image": {
    "src": "images/logo.png",
    "coords": [250, 150, 350, 400],
    "alignment": "center"
  },
  "messages": [
    {"text": "Save", "offset": [10, 20]
    {"text": "Help", "offset": [ 0, 50]
    {"text": "Quit", "offset": [30, 15]
  ],
  "debug": "true"
}
```

JSON example: Books

Suppose we have a service books_json. php about library books.

- If no query parameters are passed, it outputs a list of book categories:

```
{ "categories": ["computers", "cooking", "finance", ...] }
```

- Supply a `category` query parameter to see all books in one category:
http://webster.cs.washington.edu/books_json.php?category=cooking

```
{
  "books": [
    {"category": "cooking", "year": 2009, "price": 22.00,
     "title": "Breakfast for Dinner", "author": "Amanda Camp"},
    {"category": "cooking", "year": 2010, "price": 75.00,
     "title": "21 Burgers for the 21st Century", "author": "Stuart Reges"},
    ...
  ]
}
```

JSON exercise

Write a page that processes this JSON book data.

- Initially the page lets the user choose a category, created from the JSON data.
  - ○ Children ○ Computers ○ Finance List Books
- After choosing a category, the list of books in it appears:

Books in category "Cooking":
- Breakfast for Dinner, by Amanda Camp (2009)
- 21 Burgers for the 21st Century, by Stuart Reges (2010)
- The Four Food Groups of Chocolate, by Victoria Kirst (2005)

Working with JSON book data

```
function showBooks() {
  // add all books from the JSON data to the page's bulleted list
  var data = JSON.parse(this.responseText);
  for (var i = 0; i < data.books.length; i++) {
    var li = document.createElement("li");
    li.innerHTML = data.books[i].title + ", by " +
        data.books[i].author + " (" + data.books[i].year + ")";
    document.getElementById("books").appendChild(li);
  }
}
```

Bad style: the `eval` function

```
// var data = JSON.parse(this.responseText);
var data = eval(this.responseText);   // don't do this!
...
```

- JavaScript includes an `eval` keyword that takes a string and runs it as code
- this is essentially the same as what `JSON.parse` does,
- but `JSON.parse` filters out potentially dangerous code; `eval` doesn't
- `eval` is evil and should not be used!

Emitting JSON data manually in PHP

```
...
header("Content-type: application/json");
print "{\n";
print "  \"books\": [\n";
foreach ($books as $book) {
  print "  {\"author\": \"{$book['author']}\", \"title\": \"{$book['title']}\"}\n";
}
print "\n";
```

- specify a content type of `application/json`
- messy, just like when manually printing XML (not recommended)

PHP's JSON functions

PHP includes the following global functions for interacting with JSON data:

json_decode(*string*)	parses the given JSON data string and returns an equivalent associative array object (like JSON.parse in JavaScript)
json_encode(*object*)	returns JSON equivalent for the given object or array or value (like JSON.stringify in JavaScript)

- json_encode will output associative arrays as objects and normal arrays as arrays

PHP JSON example

```
<?php
$data = array(
  "library" => "Odegaard",
  "category" => "fantasy",
  "year" => 2012,
  "books" => array(
    array("title" => "Harry Potter", "author" => "J.K. Rowling"),
    array("title" => "The Hobbit", "author" => "J.R.R. Tolkien"),
    array("title" => "Game of Thrones", "author" => "George R. R. Martin"),
    array("title" => "Dragons of Krynn", "author" => "Margaret Weis"),
  )
);

header("Content-type: application/json");
print json_encode($data);
?>
```

PHP JSON example - output


```
{
  "library": "Odegaard",
  "category": "fantasy",
  "year": 2012,
  "books": [
    {"title": "Harry Potter", "author": "J.K. Rowling"},
    {"title": "The Hobbit", "author": "J.R.R. Tolkien"},
    {"title": "Game of Thrones", "author": "George R. R. Martin"},
    {"title": "Dragons of Krynn", "author": "Margaret Weis"},
  ]
}
```