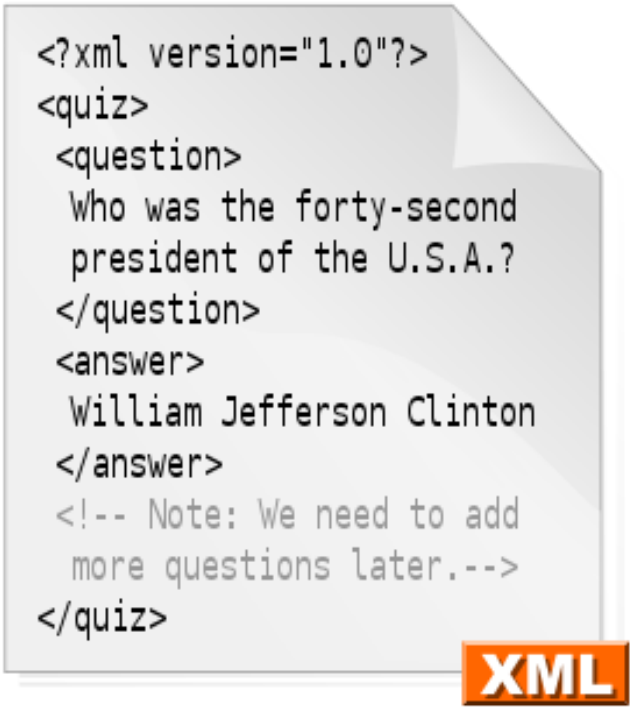
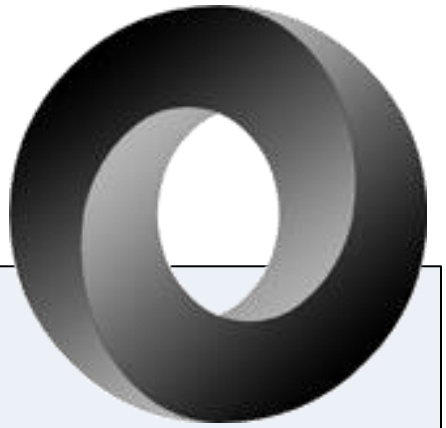
Data formats




```xml
<?xml version="1.0"?>
<quiz>
 <question>
  Who was the forty-second
  president of the U.S.A.?
 </question>
 <answer>
  William Jefferson Clinton
 </answer>
 <!-- Note: We need to add
  more questions later.-->
</quiz>
```

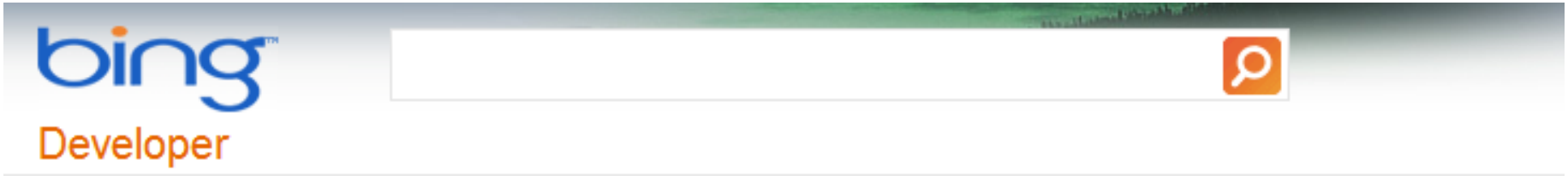


```
{
     "firstName": "John",
     "lastName" : "Smith",
     "age"      : 25,
     "address"  :
     {
         "streetAddress": "21 2nd Street",
         "city"         : "New York",
         "state"        : "NY",
         "postalCode"   : "10021"
     },
```

Overview

- Last time:
  - Web services
    - A simple GET request (REST)
    - Or a more complicated XML message (SOAP)
- How to store or interchange data?
  - XML
  - JSON
  - Homebrewed ASCII format

Bing web services



Develop with Bing

Use Bing Search and Map APIs to increase your website's functionality and user appeal, or to create enterprise/consumer applications.

Sign in - Bing Search API

Sign up to use Bing Search API and create AppIDs
Learn more

Create unique search applications

- Build applications powered by Bing's technology
- Choose from multiple SourceTypes (Web, Images, Video, and More) and output protocols (JSON, SOAP, or XML)
- Customize the search results to your needs

Sign in - Bing Maps

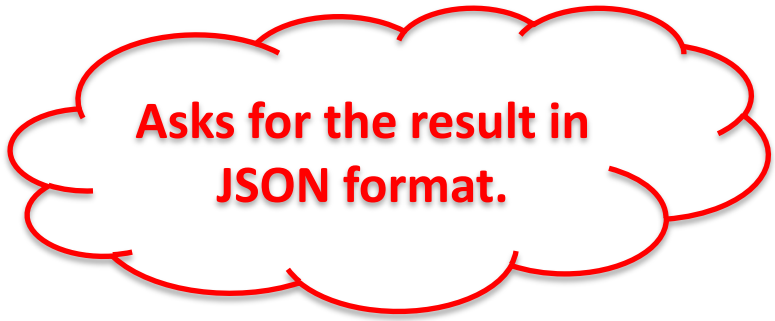
Sign up to use Bing Maps
Learn more

Create your own mapping applications

- Feature maps that render fast and deliver stunning imagery
- Easily scale from a simple static map up to the most complex interactive spatial application
- Build for mobile using our tools for Windows Phone 7, Android, and iOS

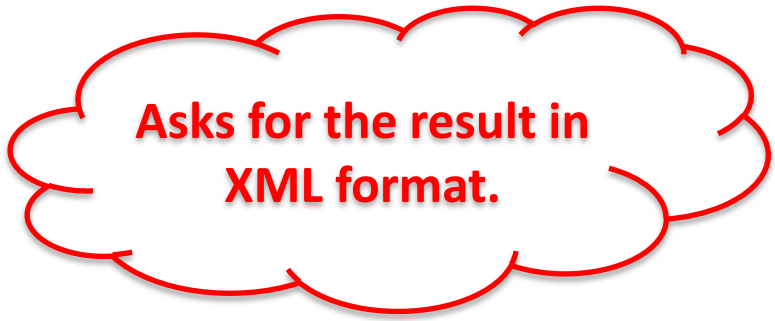
Using Bing search API

- Find the top-10 Bing results for "orediggers"
  - Make a HTTP GET request
  - `https://api.datamarket.azure.com/Bing/Search/Web?Query=%27orediggers%27&$top=10&$format=json`

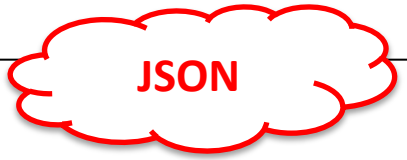


Using Bing search API

- Find the top-10 Bing results for "orediggers"
  - Make a HTTP GET request
  - `https://api.datamarket.azure.com/Bing/Search/Web?Query=%27orediggers%27&$top=10&$format=atom`



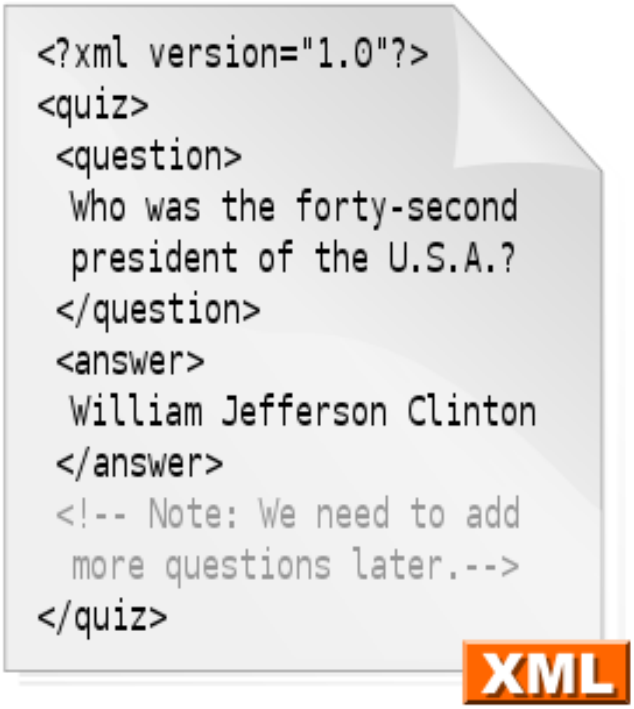

```
<?xml version="1.0" encoding="UTF-8"?>
<feed xmlns="http://www.w3.org/2005/Atom" xmlns:base="https://api.datamarket.azure.com
/Data.ashx/Bing/Search/Web" xmlns:d="http://schemas.microsoft.com/ado/2007
/08/dataservices" xmlns:m="http://schemas.microsoft.com/ado/2007/08/dataservices
/metadata">
   <title type="text">oredigger</title>
   <subtitle type="text">Bing Web Search</subtitle>
   <id>https://api.datamarket.azure.com/Data.ashx/Bing/Search/Web?Query='oredigger'&
amp;$top=10</id>
   <rights type="text" />
   <updated>2013-02-04T16:55:20Z</updated>
   <link rel="next" href="https://api.datamarket.azure.com/Data.ashx/Bing/Search
/Web?Query='oredigger'&amp;$skip=10&amp;$top=10" />
   <entry>
      <id>https://api.datamarket.azure.com/Data.ashx/Bing/Search/Web?Query='oredigger'&
amp;$skip=0&amp;$top=1</id>
      <title type="text">WebResult</title>
      <updated>2013-02-04T16:55:20Z</updated>
      <content type="application/xml">
```



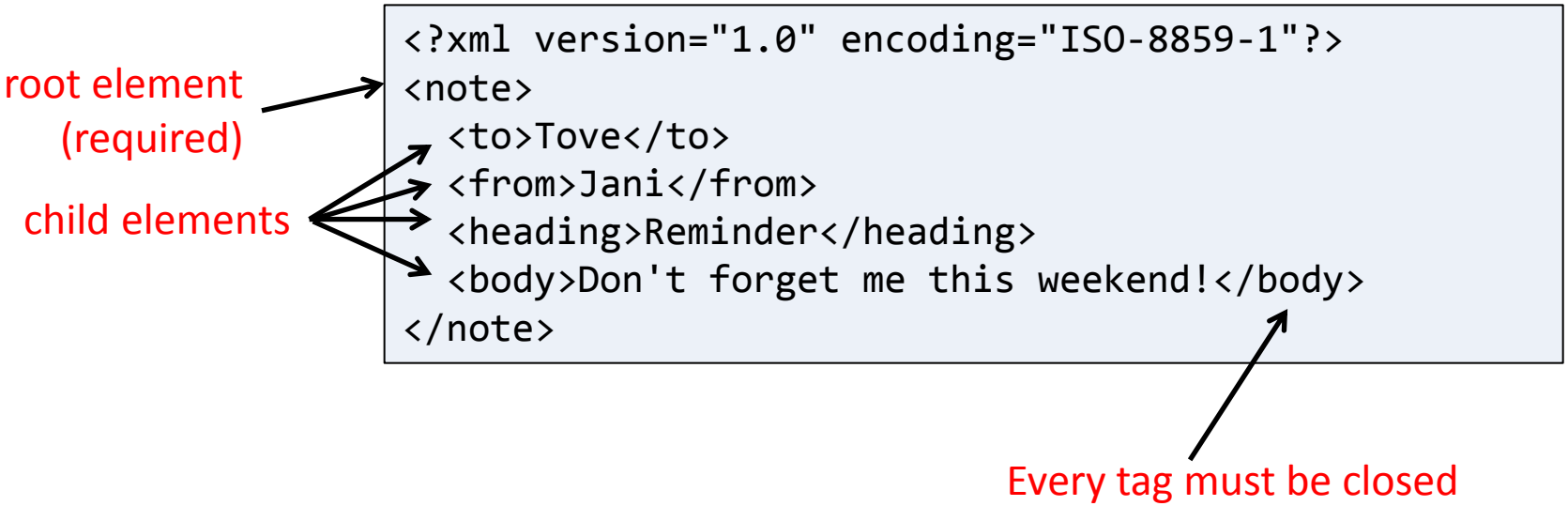

```
{
   "SearchResponse":{
      "Version":"2.2",
      "Query":{
         "SearchTerms":"orediggers"
      },
      "Web":{
         "Total":53300,
         "Offset":0,
         "Results":[
            {
               "Title":"Colorado School of Mines Athletics",
               "Description":"Official site of the Orediggers with scores, statistics, pictures, and rosters.",
               "Url":"http:\/\/www.csmorediggers.com\/",
               "DisplayUrl":"www.csmorediggers.com",
               "DateTime":"2012-01-31T12:35:00Z"
            },
            {
               "Title":"Montana Tech Athletics",
               "Description":"Official site of the Orediggers with news items, scores, statistics, player profiles,
               "Url":"http:\/\/www.godiggers.com\/",
               "DisplayUrl":"www.godiggers.com",
               "DateTime":"2012-01-31T22:30:00Z",
               "DeepLinks":[
                  {
                     "Title":"Digger Football",
                     "Url":"http:\/\/www.godiggers.com\/football\/football.html"
                  },
                  {
                     "Title":"Football",
                     "Url":"http:\/\/www.godiggers.com\/football.html"
                  },
```

Data format: XML

- XML (Extensible Markup Language)
  - Human "readable"
  - W3C recommendation
  - Markup language like HTML
  - Originally a document format
    - Microsoft Office (Office Open XML)
    - OpenOffice (OpenDocument)
    - Apple iWork
  - Can be used for data interchange
    - e.g. SOAP, RSS, Atom



XML




```
<b><i>This text is bold and italic</b></i>
```

Example of *improperly* nested HTML

```
<b><i>This text is bold and italic</i></b>
```

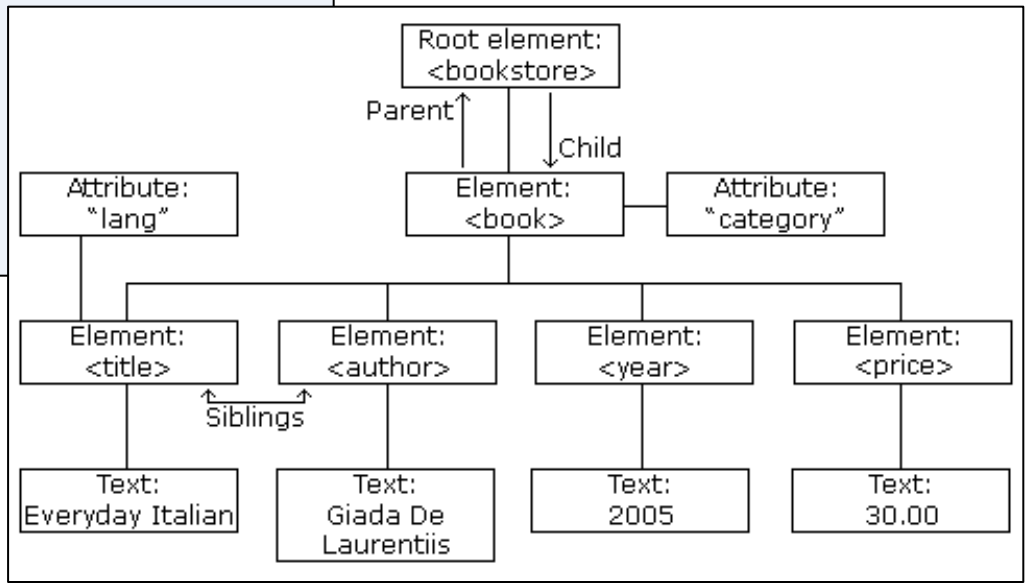
Properly nested XHTML

```
<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="CHILDREN">
    <title lang="en">Harry Potter</title>
    <author>J K. Rowling</author>
    <year>2005</year>
    <price>29.99</price>
  </book>
  <book category="WEB">
    <title lang="en">Learning XML</title>
    <author>Erik T. Ray</author>
    <year>2003</year>
    <price>39.95</price>
  </book>
  <!-- This is a comment -->
</bookstore>
```

Tags are case-sensitive,
<title> != <Title>

Attributes must be quoted

A comment in the XML document



```
<p>This is a paragraph.
<br>
```

Unclosed tags in an HTML document.

```
<p>This is a paragraph.</p>
<br />
```

In XHTML, every tag must be closed.

Whitespace is preserved

```
<message>if    salary &lt; 1000 then</message>
```

Special characters need to be escaped.

&lt;	<	less than
&gt;	>	greater than
&amp;	&	ampersand
&apos;	'	apostrophe
&quot;	"	quotation mark

```
<note date="10/01/2008">
  <to>Tove</to>
  <from>Jani</from>
  <heading>Reminder</heading>
  <body>Don't forget me this weekend!</body>
</note>
```

```
<note>
  <date>10/01/2008</date>
  <to>Tove</to>
  <from>Jani</from>
  <heading>Reminder</heading>
  <body>Don't forget me this weekend!</body>
</note>
```

```
<note>
  <date>
    <day>10</day>
    <month>01</month>
    <year>2008</year>
  </date>
  <to>Tove</to>
  <from>Jani</from>
  <heading>Reminder</heading>
  <body>Don't forget me this weekend!</body>
</note>
```

Validating XML

- Method 1: Document Type Definition (DTD)

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<!DOCTYPE note SYSTEM "Note.dtd">
<note>
  <to>Tove</to>
  <from>Jani</from>
  <heading>Reminder</heading>
  <body>Don't forget me this weekend!</body>
</note>
```

```
<!DOCTYPE note
[
<!ELEMENT note (to,from,heading,body)>
<!ELEMENT to (#PCDATA)>
<!ELEMENT from (#PCDATA)>
<!ELEMENT heading (#PCDATA)>
<!ELEMENT body (#PCDATA)>
]>
```

Validating XML

- Method 2: XML Schema
  - XSD (XML Schema Definition)

```
<xs:element name="note">

<xs:complexType>
  <xs:sequence>
    <xs:element name="to"      type="xs:string"/>
    <xs:element name="from"    type="xs:string"/>
    <xs:element name="heading" type="xs:string"/>
    <xs:element name="body"    type="xs:string"/>
  </xs:sequence>
</xs:complexType>

</xs:element>
```

Parsing XML

- DOM (Document Object Model)
  - Expressing and interacting with XML data
    - Reading and writing to the XML
  - Modern browsers/languages, built-in DOM parser:
    - libxml2 - Bindings for C++, C#, Python, PHP, Perl, …
    - MSXML - Microsoft XML Core Services
  - Loads whole XML tree
- SAX (Simple API for XML)
  - Sequential event driven API
    - Reading from the XML
- Simple string parsing
  - Find stuff between start and end tag
    - Probably naughty… but fast…
    - Might be an option if you control the XML data as well

```
<html><body><h1>W3Schools Internal Note</h1>
<div>
<b>To:</b> <span id="to"></span><br />
<b>From:</b> <span id="from"></span><br />
<b>Message:</b> <span id="message"></span>
</div>

<script type="text/javascript">
if (window.XMLHttpRequest)
{ // code for IE7+, Firefox, Chrome, Opera, Safari
  xmlhttp = new XMLHttpRequest();
}
else
{ // code for IE6, IE5
  xmlhttp = new ActiveXObject("Microsoft.XMLHTTP");
}
xmlhttp.open("GET","note.xml",false);
xmlhttp.send();
xmlDoc = xmlhttp.responseXML;

document.getElementById("to").innerHTML =
    xmlDoc.getElementsByTagName("to")[0].childNodes[0].nodeValue;
document.getElementById("from").innerHTML =
    xmlDoc.getElementsByTagName("from")[0].childNodes[0].nodeValue;
document.getElementById("message").innerHTML =
    xmlDoc.getElementsByTagName("body")[0].childNodes[0].nodeValue;
</script>
</body></html>
```

JavaScript fills in the HTML elements based on loading an XML object into the DOM and then picking out elements.

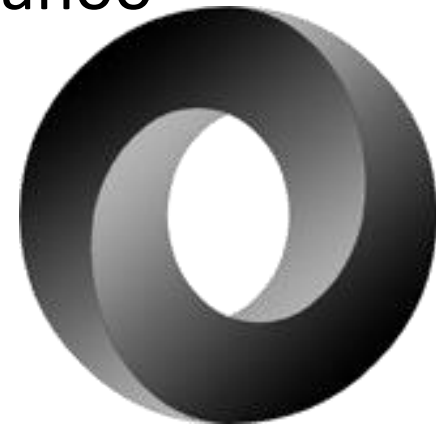
SAX parsing

```
<?xml version="1.0" encoding="UTF-8"?>
<RootElement param="value">
    <FirstElement>
        Some Text
    </FirstElement>
    <?some_pi some_attr="some_value"?>
    <SecondElement param2="something">
        Pre-Text <Inline>Inlined text</Inline> Post-text.
    </SecondElement>
</RootElement>
```

- Event sequence to SAX parser:
  - XML element start *RootElement*, attribute *param* = *value*
  - XML element start FirstElement
  - XML text node, data = "Some Text"
  - XML element end FirstElement
  - …

Data format: JSON

- JSON (JavaScript Object Notation), "Jason"
  - 2001 Popularized by Doug Crockford, Yahoo
    - http://youtu.be/-C-JoyNuQJs
  - Lightweight alternative to XML
    - Spec fits on the back of a business card
  - Human readable
  - Derived from how JavaScript represents data structures and associative arrays
  - Language independent data interchange



```
{to:"session", do:"test", text:"Hello world"}
```

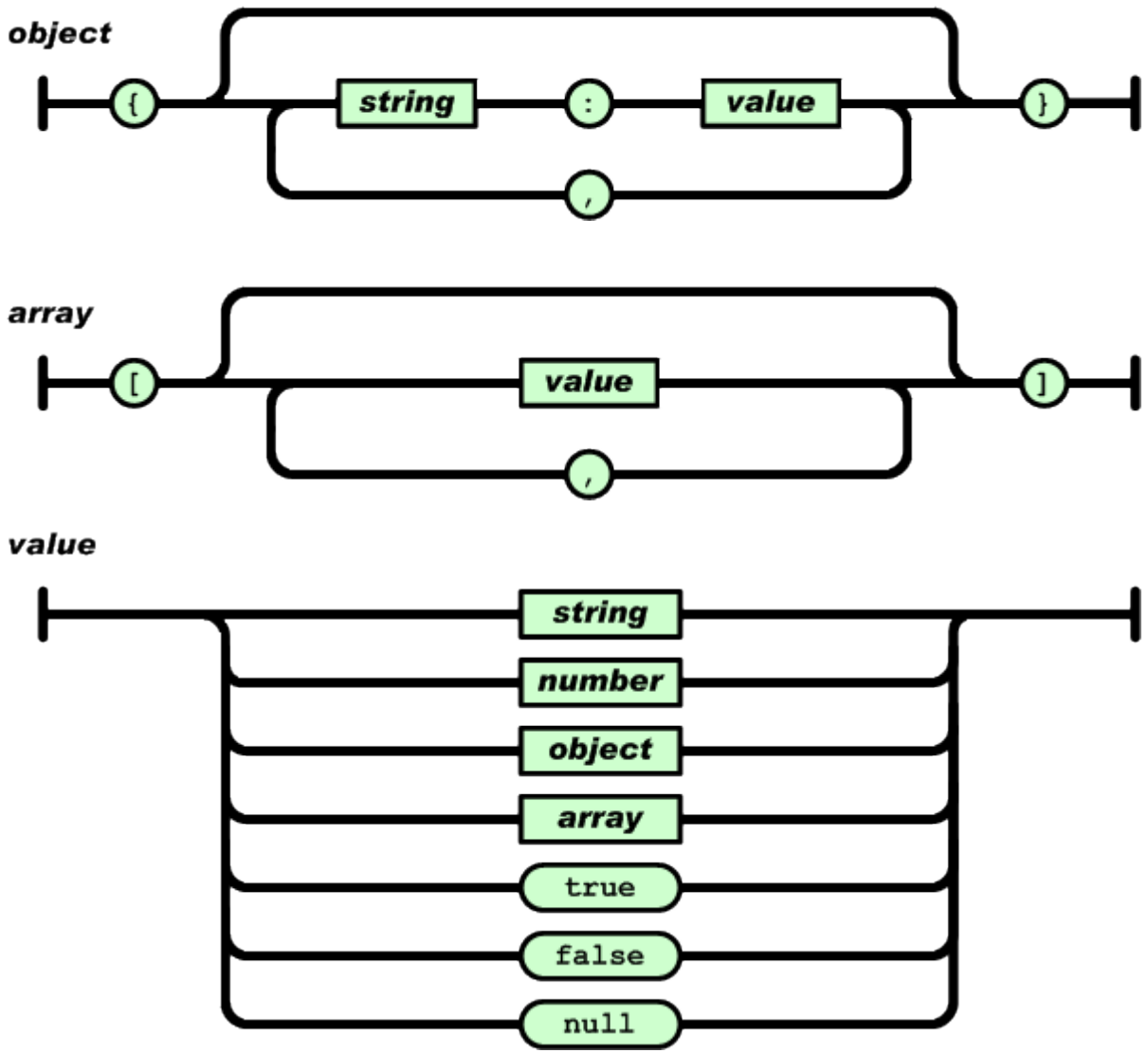
The world's first JSON message, April 2001.

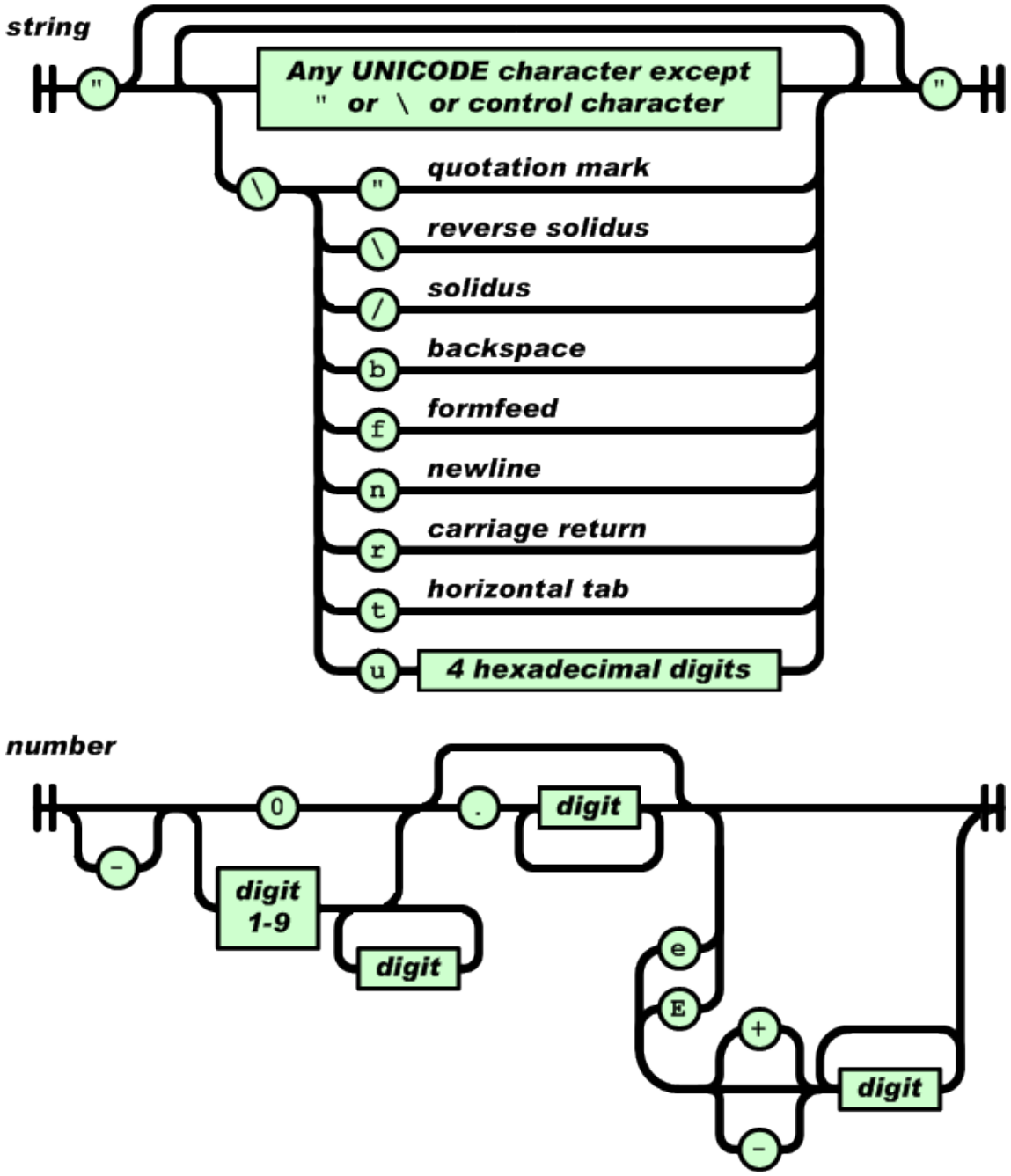
Failed due to JavaScript reserved word "do".
Decided to always force quoting of key.

JSON example

```
{
     "firstName": "John",
     "lastName" : "Smith",
     "age"      : 25,
     "address"  :
     {
         "streetAddress": "21 2nd Street",
         "city"         : "New York",
         "state"        : "NY",
         "postalCode"   : "10021"
     },
     "phoneNumber":
     [
         {
           "type"  : "home",
           "number": "212 555-1234"
         },
         {
           "type"  : "fax",
           "number": "646 555-4567"
         }
     ]
 }
```

JSON's grammar




string
"
Any UNICODE character except
" or \ or control character
"
\
"
quotation mark
\
reverse solidus
/
solidus
b
backspace
f
formfeed
n
newline
r
carriage return
t
horizontal tab
u
4 hexadecimal digits
number
-
0
digit
1-9
digit
.
digit
e
E
+
-
digit

Parsing JSON

- In JavaScript
  - JSON is subset of the literal JavaScript notation

```
var myJSONObject = {"bindings":
  [
    {"ircEvent": "PRIVMSG", "method": "newURI",    "regex": "^http://.*"},
    {"ircEvent": "PRIVMSG", "method": "deleteURI", "regex": "^delete.*"},
    {"ircEvent": "PRIVMSG", "method": "randomURI", "regex": "^random.*"}
  ]
};
```

```
myJSONObject.bindings[0].method  // "newURI"
```

Parsing JSON

- In Java
  - Freely available parsing class `JSONObject`

Method Summary	
JSONObject	accumulate(java.lang.String key, java.lang.Object value) Accumulate values under a key.
JSONObject	append(java.lang.String key, java.lang.Object value) Append values to the array under a key.
static java.lang.String	doubleToString(double d) Produce a string from a double.
java.lang.Object	get(java.lang.String key) Get the value object associated with a key.
boolean	getBoolean(java.lang.String key) Get the boolean value associated with a key.
double	getDouble(java.lang.String key) Get the double value associated with a key.
int	getInt(java.lang.String key) Get the int value associated with a key.
JSONArray	getJSONArray(java.lang.String key) Get the JSONArray value associated with a key.

- ASP:
  - JSON for ASP.
  - JSON ASP utility class.
- ActionScript:
  - ActionScript3.
  - JSONConnector.
- Ada:
  - GNATCOLL.JSON.
- Bash:
  - Jshon.
  - JSON.sh.
- BlitzMax:
  - bmx-rjson.
- C:
  - JSON_checker.
  - YAJL.
  - js0n.
  - LibU.
  - json-c.
  - json-parser.
  - jsonsl.
  - WJElement.
  - M's JSON parser.
  - cJSON.
  - Jansson.
  - jsmn.
  - cson.
  - parson.
- C++:
  - JSONKit.
  - jsonme--.
  - ThorsSerializer.
  - JsonBox.
  - jsoncpp.
  - zoolib.
  - JOST.
  - CAJUN.
  - libjson.
  - nosjob.
  - rapidjson.
- C#:
  - fastJSON.
  - JSON_checker.
  - Jayrock.
  - Json.NET - LINQ to JSON.
  - LitJSON.
  - JSON for .NET.
  - JsonFx.
  - JSON@CodeTitans
  - How do I write my own parser?
  - JSONSharp.
  - JsonExSerializer.
  - fluent-json
  - Manatee Json
- Ciao:
  - Ciao JSON encoder and decoder
- Clojure:
  - clojure-json.
  - API for json.
- Cobol:
  - XML Thunder.
- ColdFusion:
  - ColdFusion 8.
  - toJSON.
- D:
  - Cashew.
  - Libdjson.
- Dart:
  - json library.
- Delphi:
  - Delphi Web Utils.
  - JSON Delphi Library.
  - JSON Toolkit.
  - tiny-json.
- E:
  - JSON in TermL.
- Erlang:
  - ejson.
  - mochijson2.
- Fantom:
  - Json.
- Go:
  - package json.
- Haskell:
  - RJson package.
  - json package.
- haXe:
  - hxJSON.
- Java:
  - org.json.
  - org.json.me.
  - Jackson JSON Processor.
  - Json-lib.
  - JSON Tools.
  - Stringtree.
  - SOJO.
  - Jettison.
  - json-taglib.
  - XStream.
  - Flexjson.
  - JON tools.
  - Argo.
  - jsonij.
  - fastjson.
  - mjson.
  - jjson.
  - json-simple.
  - json-io.
  - JsonMarshaller.
  - google-gson.
  - Json-smart.
  - FOSS Nova JSON.
- JavaScript:
  - JSON.
  - json2.js.
  - json_sans_eval.
  - clarinet.
- Lisp:
  - Common Lisp JSON.
  - Yason.
  - Emacs Lisp.
- LotusScript:
  - JSON LS.
- Lua:
  - Json4Lua.
  - LuaJSON.
  - LuaJSON C Library.
  - Lua CJSON.
  - dkjson.
- LabVIEW:
  - JSON Toolkit.
- M:
  - DataBallet.
- Matlab:
  - JSONlab.
  - JSON Parser.
  - (another) JSON Parser.
- Objective C:
  - json-framework.
  - MTJSON.
  - JSONKit.
  - yajl-objc.
  - TouchJSON.
- OCaml:
  - Yojson.
  - jsonm.
- OpenLaszlo:
  - JSON.
- Perl:
  - CPAN.
  - perl-JSON-SL.
- PHP:
  - PHP 5.2.
  - json.
  - Services_JSON.
  - Zend_JSON.
  - Solar_Json.
  - Comparison of php json libraries.
- Pike:
  - Public.Parser.JSON.
  - Public.Parser.JSON2.
- PL/SQL:
  - pljson:
  - Librairie-JSON.
- PowerShell:
  - PowerShell.
- Prolog:
  - SWI-Prolog HTTP support
- Puredata:
  - PuRestJson
- Python:
  - The Python Standard Library.
  - simplejson.
  - pyson.
  - Yajl-Py.
  - ultrajson.
  - metamagic.json.
- Qt:
  - QJson.
- R:
  - rjson.
- Racket:
  - json-parsing.
- Rebol:
  - json.r.
- RPG:
  - JSON Utilities.
- Ruby:
  - json.
  - yajl-ruby.
  - json-stream.
- Scala:
  - package json.
- Scheme:
  - MZScheme.
  - PLT Scheme.
- Squeak:
  - Squeak.
- Symbian:
  - s60-json-library.
- Tcl:
  - JSON.
- Visual Basic:
  - VB-JSON.
  - PW.JSON.
- Visual FoxPro:
  - fwJSON.
  - JSON.
  - vfpjson.

Simplicity of the JSON data format resulted in porting to many, many languages.

- Intersection of data formats of modern languages:
  - Simple values
    - Number, string, boolean
  - Sequence of values
    - array, vector, list
  - Collection of named values
    - object, record, struct, hash, property

Works easily with JavaScript.

Used for pulling data from server in "Ajax" web applications.

Summary

- Common data formats:
  - XML
    - Grew out of document SGML format
    - Validating with DTDs and XML schema
    - Parsing using DOM or SAX
  - JSON
    - Grew out of need to interchange data
    - Simple grammar
    - Supported in most languages