Data Representation and Querying

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Topics

About this module

HTTP

REST

JSON

XML

AJAX

HTTP APIs

NoSQL

Map Reduce

About this module

Learning outcomes

On completion of this module the learner will/should be able to:

- Explain the benefits and the limitations of a variety of data models.
- Determine the most appropriate data model given a set of requirements.
- Represent, integrate and query large datasets using existing API's and frameworks.
- Describe the principles behind both the linked data and the open data movements.

Examinations

Type	%	Date
Project	50	Week 8
End of Semester Exam	50	See exams timetable

HTTP

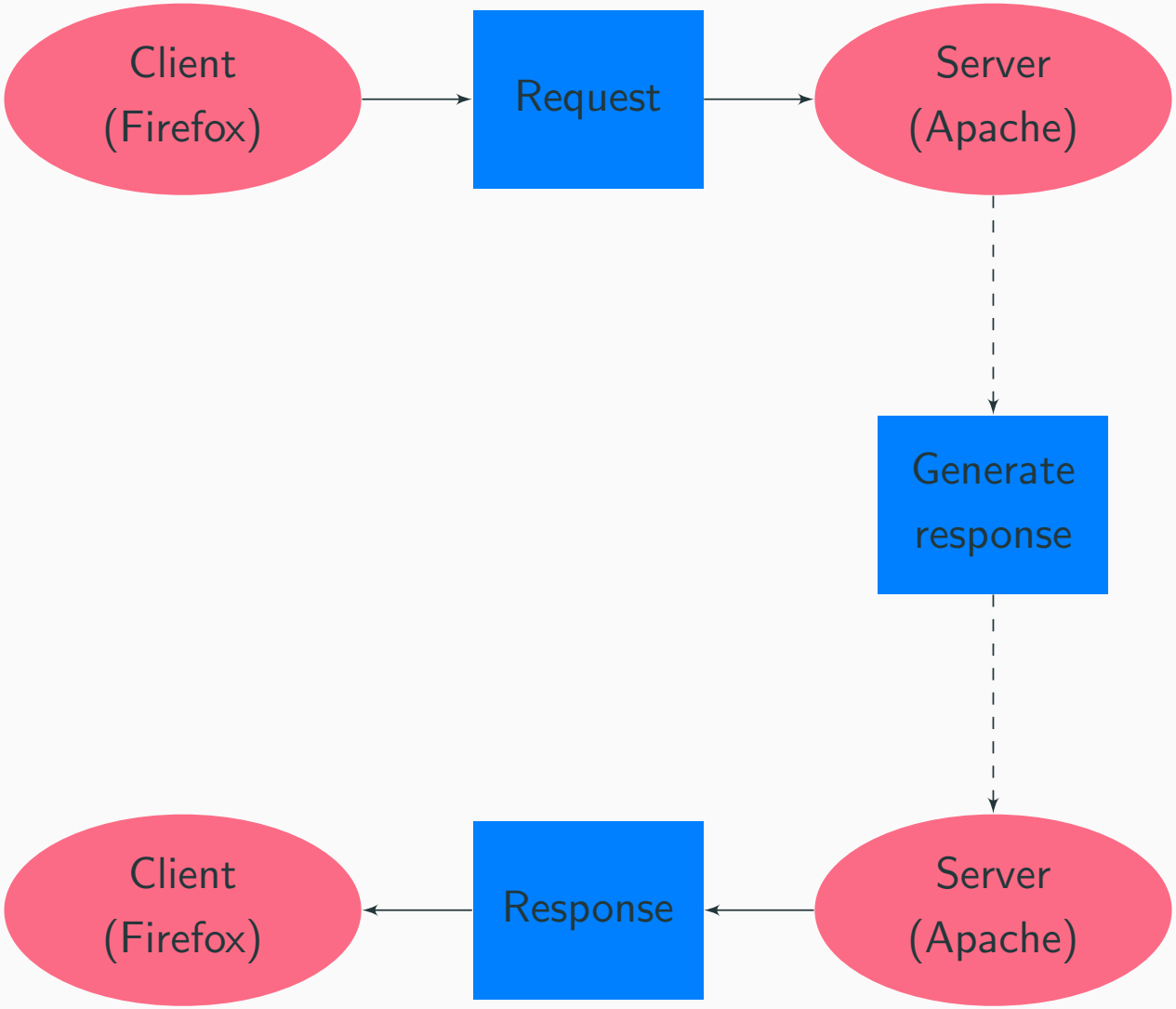
HyperText Transfer Protocol

HyperText Text with links.

Transfer Communication of data.

Protocol Set of rules for communication.

Request–Response

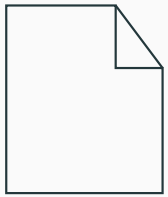


Uniform Resource Locator

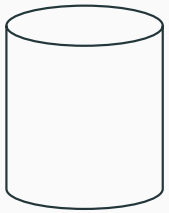
http://username:password@www.reddit.com:80/r/funny/?limit=1

http	Protocol
username	Username
password	Password
www	Subdomain
reddit.com	Domain
80	Port
/r/funny/	Path
limit=1	Parameter

Resources



File



Database

HTTP is used to transmit resources . . . A resource is some chunk of information that can be identified by a URL . . . The most common kind of resource is a file, but a resource may also be a dynamically-generated query result . . .

HTTP Methods

GET	Retrieve information from the server.
HEAD	Like get, but retrieve only the response header.
POST	Send data to the server.
PUT	Set the resource at the URL to the request data.
DELETE	Delete the resource at the URL.
CONNECT	Set up tunnel for other traffic to pass through HTTP.
OPTIONS	Find the allowable operations at the given URL.
TRACE	Echo the received request.
PATCH	Partial resource modification.

Request and Response Format

Requests and responses both have this format:

- Intial line.
- Zero or more header lines.
- A blank line.
- Optional message body (e.g. a HTML file)

Request (GET) Example

```
GET /path/item/1?q=Funny+cats HTTP/1.0
From: someuser@jmarshall.com
User-Agent: HTTPTool/1.0
```

Request (POST)

```
POST /path/script.cgi HTTP/1.0
From: frog@jmarshall.com
User-Agent: HTTPTool/1.0
Content-Type: application/x-www-form-urlencoded
Content-Length: 32

home=Cosby&favorite+flavor=flies
```

Response Example

```
HTTP/1.1 200 OK
Date: Mon, 27 Jul 2009 12:28:53 GMT
Server: Apache/2.2.14 (Win32)
Last-Modified: Wed, 22 Jul 2009 19:15:56 GMT
Content-Length: 88
Content-Type: text/html
Connection: Closed

<html>
  <body>
    <h1>Hello, World!</h1>
  </body>
</html>
```

URL encoding

HTML form data is usually URL-encoded by changing;

- Unsafe characters to % *xx* where *xx* is the ASCII value.
- All spaces to plusses.
- Names and values to: name1=value1&name2=value2.

GET Parameters go in the URL after ?, e.g. http://www.google.ie?q=Funny+cats.

POST Parameters go in the body.

Security

- HTTP is not encrypted.
- HTTPS is a protocol based on HTTP, but it provides security.
- GET and POST are by far the most commonly used HTTP methods (by web developers).
- Data sent by GET and POST will be encrypted over HTTPS.
- However, it's generally accepted that POST is more secure for sending sensitive data.
- This is because browsers will typically cache and servers will typically log URLS, with the data encoded in them.

REST

REST

- REST stands for Representational State Transfer.
- REST is an architecture describing how we might use HTTP.
- RESTful APIs make use of more HTTP methods than just GET and POST.
- Most HTTP APIs are not RESTful.
- RESTful APIs adhere to a few loosely defined constraints.
- Two of those constraints are that the API is stateless and cacheable.

drdobbs.com/web-development/restful-web-services-a-tutorial/240169069

Typical example

Suppose we have a system for storing and retrieving emails.

Method	URL	Description
GET	/emails	list all emails
POST	/email	store new email
GET	/email/32	retrieve email with id 32
PUT	/email/32	update email with id 32
DELETE	/email/32	delete email with id 32

bitworking.org/news/201/restify-daytrader

Stateless

- Statelessness is a REST constraint.
- HTTP uses the client-server model.
- The server should treat each request as a single, independent transaction.
- No client state should be stored on the server.
- Each request must contain all of the information to perform the request.

Cacheable

- REST APIs should provide responses that are cacheable.
- Intermediaries between the client and server should be able to cache responses.
- This should be transparent to the client.
- Cacheability increases response time.
- Browsers usually cache resources, in case they are requested again.
- There is usually a time limit on cached resources.

JSON

JSON

JavaScript A scripting/programming language.

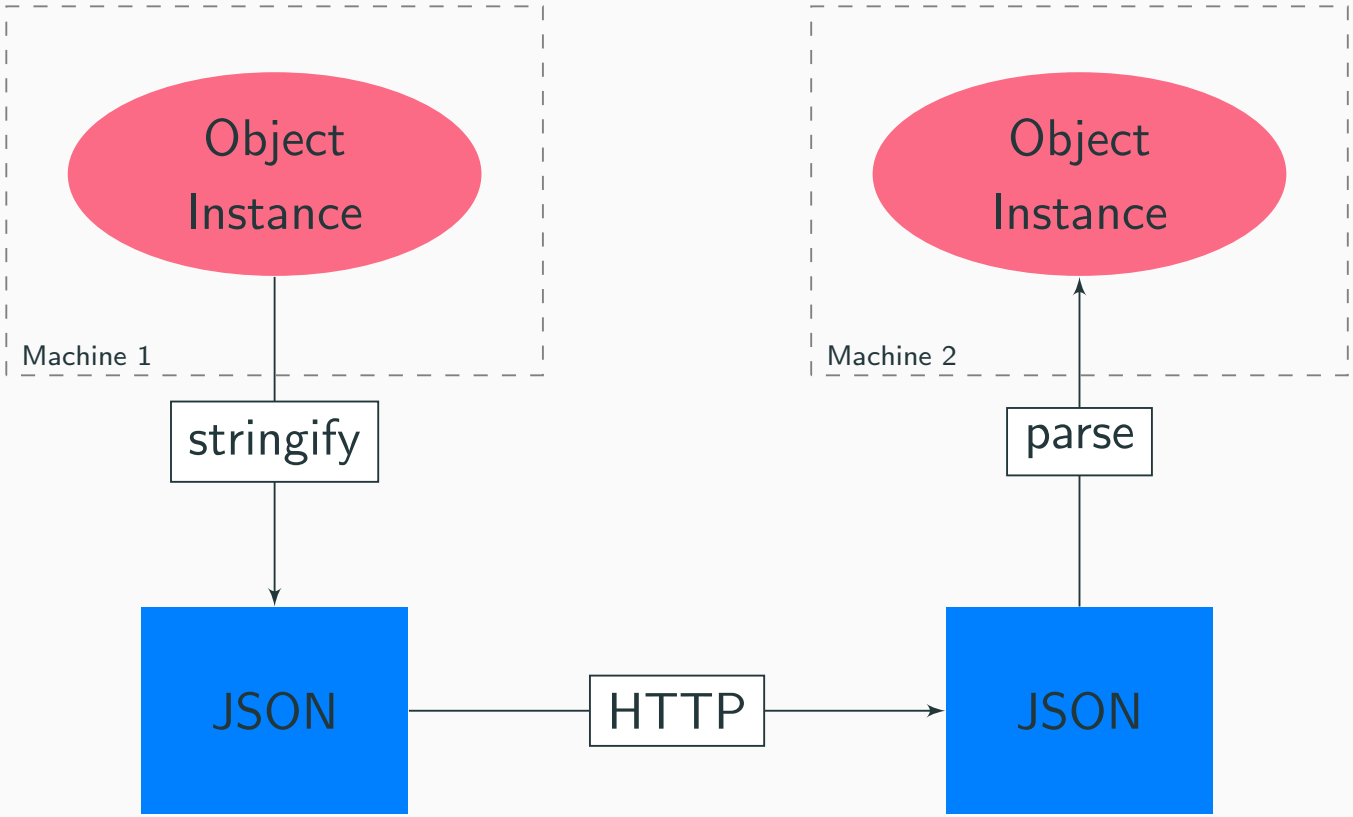
Object Groups of name–value pairs.

Notation Set of rules for representing objects.

About JSON

- JSON is just text, but text that conforms to a syntax.
- JSON is heavily influenced by JavaScript, but it is used in with all languages.
- JSON's primary purpose is to represent information in text form.
- JSON is popular because it is easy to send over HTTP and parse in JavaScript.

Sending JSON



JSON Example

```
{
  "employees": [
    {"firstName":"John", "lastName":"Doe"},
    {"firstName":"Anna", "lastName":"Smith"},
    {"firstName":"Peter", "lastName":"Jones"}
  ]
}
```

Using JSON in JavaScript

```
// Turning text into a JavaScript object.
var obj = JSON.parse(text);
// obj is an obect.

// Turning a JavaScript object into text.
var text = JSON.stringify(obj);
// text is a string.
```

JSON Syntax

- Name/Value pairs separated by a colon.

  ```
  "name": "Ian"
  ```

- Objects identified by curly braces.

  ```
  {}
  ```

- Lists identified by square brackets.

  ```
  []
  ```

- All strings (and names) use double quotes (not single).

  ```
  "Ian"
  ```

JSON Types

- Numbers

  ```
  123.456
  ```

- Strings

  ```
  "Hello, world!"
  ```

- Boolean

  ```
  true"
  ```

- Arrays

  ```
  [1,2,3]
  ```

- Objects

  ```
  {"name": "Ian"}
  ```

- null

  ```
  null
  ```

XML

eXtensible Markup Language

Extensible Designed to accommodate change.

Markup Annotates text.

Language Set of rules for communication.

About XML

- XML is an alternative to JSON.
- XML looks like HTML, but it is different.
- XML's purpose is to represent information in text form.
- There are no pre-defined tag names – you make them up yourself.
- XML has a tree-like syntax.
- The Document Object Model (DOM) can be applied to XML.

XML Example

```
<?xml version="1.0" encoding="UTF-8"?>
<book isbn-13="978-0131774292" isbn-10="0131774298">
  <title>Expert C Programming: Deep C Secrets</title>
  <publisher>Prentice Hall</publisher>
  <author>Peter van der Linden</author>
</book>
```

XML Syntax

Declaration XML documents should have a single line at the start stating that it's XML, the version of XML it is, and an encoding.

Elements XML is structured as elements, which are enclosed in angle brackets.

Root element XML must have a single root element that wraps all others.

Attbirutes Elements can have attributes, which are name–value pairs within the angle brackets. A given attribute name can only be specified once per element.

Entity references Certain characters must be escaped with entity references, e.g. < for $\langle$.

Case sensitive Everything in XML is case sensitive.

XML Syntax Example

```
<?xml version="1.0" encoding="UTF-8"?>
<parent-element attribute-name="attribute-value">
  <child name="value">Text</child-element>
  <child name="value">Text</child-element>
  <child name="value">Text</child-element>
  <lone-warrior />
</parent-element>
```

Document Object Model

- The Document Object Model (DOM) is a programming interface for HTML and XML documents.
- It provides a model of the document as a structured group of nodes that have properties and methods.
- The DOM connects web pages to scripts or programming languages.
- You can use document.createElement, document.createTextNode and document.element.appendChild to add to the DOM.
- You can use document.getElementById to access elements of the DOM.

developer.mozilla.org/en-US/docs/Web/API/Document_Object_Model/Introduction

AJAX

Asynchronous JavaScript and XML

AJAX stands for Asynchronous JavaScript and XML.

Asynchronous In the background, and without a page refresh.

JavaScript Programming language for the web.

XML eXtensible Markup Language.

About AJAX

- AJAX allows us to make a HTTP request from JavaScript without a page refresh.
- AJAX also allows us to receive the response from that request and deal with it.
- Despite the name, we don't have to use XML – we can use JSON or anything else.
- This happens asynchronously, so that the rest of our code be run while waiting for a slower piece of code to complete.
- HTTP requests are usually relatively slow.
- We use a callback function, which is called when the HTTP transaction is complete.

AJAX Example

```
var xmlhttp = new XMLHttpRequest();

xmlhttp.onreadystatechange = function() {
  if (xmlhttp.readyState == 4) {
    var mydiv = document.getElementById("mydivid");
    mydiv.innerHTML = xmlhttp.responseText;
  }
};

xmlhttp.open("GET", "https://goo.gl/2GCplC");
xmlhttp.send();
```

AJAX Example Explained

- XMLHttpRequest is a built-in class that provides AJAX functionality in JavaScript.
- httpRequest.onreadystatechange should be set to a function to run every time something happens in our HTTP call.
- httpRequest.open is called to initialize the request.
- httpRequest.send is used to send the request to the server.
- XMLHttpRequest.readyState changes when the state of the AJAX call changes. This triggers a call to httpRequest.onreadystatechange.

Using jQuery

```
<script src="jquery.min.js"></script>
```

```
$.get("https://goo.gl/2GCplC", function(data) {
  $("#mydivid").html(data);
});
```

HTTP APIs

NoSQL

Map Reduce