

Web APIs

A Brief Introduction



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November 9, 2009

[dĭs-klā'mər]

- 1. A repudiation or denial of responsibility or connection.*
- 2. Law. A renunciation of one's right or claim.*

Disclaimer

*This introduction barely
scratches the surface of the topics at hand.*

*Feel free to ask/interrupt if anything is unclear,
incomplete or just plain wrong.*

Web 101

Human Web

vs

Machine Web



[Advanced Search](#)
[Language Tools](#)

Google Search

I'm Feeling Lucky

[Advertising Programs](#) - [Business Solutions](#) - [About Google](#)

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\$ curl www.google.com

```
<!doctype html><html><head><meta http-equiv="content-type" content="text/html; charset=ISO-8859-1"><title>Google</title><script>window.google={kEI:"YCX2SoQ2kYazA4Xp3Q4",kEXPI:"17259,21516,21766,22107,22712",kCSIE:"17259,21516,21766,22107,22712",kCSI:{e:"17259,21516,21766,22107,22712",ei:"YCX2SoQ2kYazA4Xp3Q4"},kHL:"en"};

window.google.sn="webhp";window.google.timers={load:{t:{start:(new Date).getTime()}}};try{}catch(b){}window.google.jsrt_kill=1;
var _gjwl=location;function _gjuc(){var e=_gjwl.href.indexOf("#");if(e>=0){var a=_gjwl.href.substring(e);if(a.indexOf("&q=")>0||a.indexOf("#q=")>0){a=a.substring(1);if(a.indexOf("#")==-1){for(var c=0;c<a.length;){var d=c;if(a.charAt(d)=="&")++d;var b=a.indexOf("&",d);if(b==--1)b=a.length;var f=a.substring(d,b);if(f.indexOf("fp=")==0){a=a.substring(0,c)+a.substring(b,a.length);b=c}else if(f=="cad=h")return 0;c=b}_gjwl.href="/search?"+a+"&cad=h";return 1}}return 0}function _gjp(){!(window._gjwl.hash&&window._gjuc())&&setTimeout(_gjp,500)};
window._gjp && _gjp()</script><style>td{line-height:.8em;}.gac_m td{line-height:17px;}form{margin-bottom:20px;}body,td,a,p,.h{font-family:arial,sans-serif}.h{color:#36c;font-size:20px}.q{color:#00c}.ts td{padding:0}.ts{border-collapse:collapse}em{font-weight:bold;font-style:normal}.lst{font:17px arial,sans-serif;margin-bottom:.2em;vertical-align:bottom;}input{font-family:inherit}.lsb,.gac_sb{font-size:15px;height:1.85em!important;margin:.2em;}#gbar{height:22px}.gbh,.gbd{border-top:1px solid #c9d7f1;font-size:1px}.gbh{height:0;position:absolute;top:24px;width:100%}#guser{padding-bottom:7px !important;text-align:right}#gbar,#guser{font-size:13px;padding-top:1px !important}@media all{.gb1,.gb3{height:22px;margin-right:.5em;vertical-align:top}#gbar{float:left}}a.gb1,a.gb3,a.gb4{color:#00c !important}.gb3{text-decoration:none}</style><script>google.y={};google.x=function(e,g){google.y[e.id]=[e,g];return false}</script></head><body bgcolor=#ffffff text=#000000 link=#0000cc vlink=#551a8b alink=#ff0000 onload="document.f.q.focus();if(document.images)new Image().src='/images/nav_logo7.png'" topmargin=3 marginheight=3><textarea id=csi style=display:none></textarea><iframe name=wgjff style=display:none></iframe><div id=gbar><noabr><b class=gb1>Web</b> <a href="http://images.google.com/imghp?hl=en&tab=wi" class=gb1>Images</a> <a href="http://video.google.com/?hl=en&tab=vw" class=gb1>Videos</a> <a href="http://maps.google.com/maps?hl=en&tab=wl" class=gb1>Maps</a> <a href="http://news.google.com/nwshp?hl=en&tab=wn" class=gb1>News</a> <a href="http://www.google.com/prdhp?hl=en&tab=wf" class=gb1>Shopping</a> <a href="http://mail.google.com/mail/?hl=en&tab=wm" class=gb1>Gmail</a> <a href="http://www.google.com/intl/en/options/" class=gb3><u>more</u><br></a></noabr></div><div id=guser width=100%><noabr><a href="/url?sa=p&pref=ig&pval=3&q=http://www.google.com/ig%3Fhl%3Den%26source%3Diglk&usg=AFQjCNFA18XPfqb7dKnXfKz7x7g1GDH1tg" class=gb4>iGoogle</a> | <a href="/preferences?hl=en" class=gb4>Search settings</a> | <a href="https://www.google.com/accounts/Login?hl=en&continue=http://www.google.com/" class=gb4>Sign in</a></noabr></div><div class=gbh style=left:0></div><div class=gbh style=right:0></div><center><br clear=all id=lgpd><a href="/search?q=sesame+street&ct=oscar-hp&oi=ddle"><img src=/logos/oscar-hp.gif width=265 height=99 border=0 alt="40th Anniversary of Sesame Street" title="40th Anniversary of Sesame Street" id=logo onload="window.lol&&lol()"></a><br><br><form action="/search" name=f><table cellpadding=0 cellspacing=0><tr valign=top><td width=25%>&nbsp;</td><td align=center nowrap><input name=hl type=hidden value=en><input name=source type=hidden value=hp><input type=hidden name=ie value="ISO-8859-1"><input autocomplete="off" maxlength=2048 name=q size=55 class=lst title="Google Search" value=""><br><input name=btnG type=submit value="Google Search" class=lsb><input name=btnI type=submit value="I'm Feeling Lucky" class=lsb></td><td nowrap width=25% align=left><font size=-2>&nbsp;&nbsp;&nbsp;<a href=/advanced_search?hl=en>Advanced Search</a><br>&nbsp;&nbsp;&nbsp;<a href=/language_tools?hl=en>Language Tools</a></font></td></tr></table></form><br><br><font size=-1><a href="/intl/en/ads/">Advertising&nbsp;Programs</a> - <a href="/services/">Business Solutions</a> - <a href="/intl/en/about.html">About Google</a></font><p><font size=-2>&copy;2009 - <a href="/intl/en/privacy.html">Privacy</a></font></p></center><div id=xjsd></div><div id=xjsi><script>if(google.y)google.y.first=[ ];if(google.y)google.y.first=[ ];google.dstr=[ ];google.rein=[ ];window.setTimeout(function(){var a=document.createElement("script");a.src="/extern_js/f/CgJlbhICdXMgACswCjhCQAgSKzA00AKsKzAYOAKsKzAlOMmIASwrMCY4BSwrMCC4Aiw/rANgNWSk54s.js";(document.getElementById("xjsd")||document.body).appendChild(a)},0);
;google.y.first.push(function()
{google.ac.m=1;google.ac.b=true;google.ac.i(document.f,document.f.q,' ','')});google.xjs&&google.j&&google.j.xi&&google.j.xi()</script></div><script>(function(){
function a(){google.timers.load.t.ol=(new Date).getTime();google.report&&google.report(google.timers.load,google.kCSI)}if(window.addEventListener)window.addEventListener("load",a,false);else if(window.attachEvent)window.attachEvent("onload",a);google.timers.load.t.prt=(new Date).getTime();
})();</script>
```

Human Web
unstructured
transient
visual

vs

Machine Web
structured
durable
non-visual

Human Web
web sites **vs** **Machine Web**
web apis*

* web services

web service / api



*client & server
communicating over
HTTP**

Example

flickr*r*

Daniel Gasienica · Sets

Slideshow



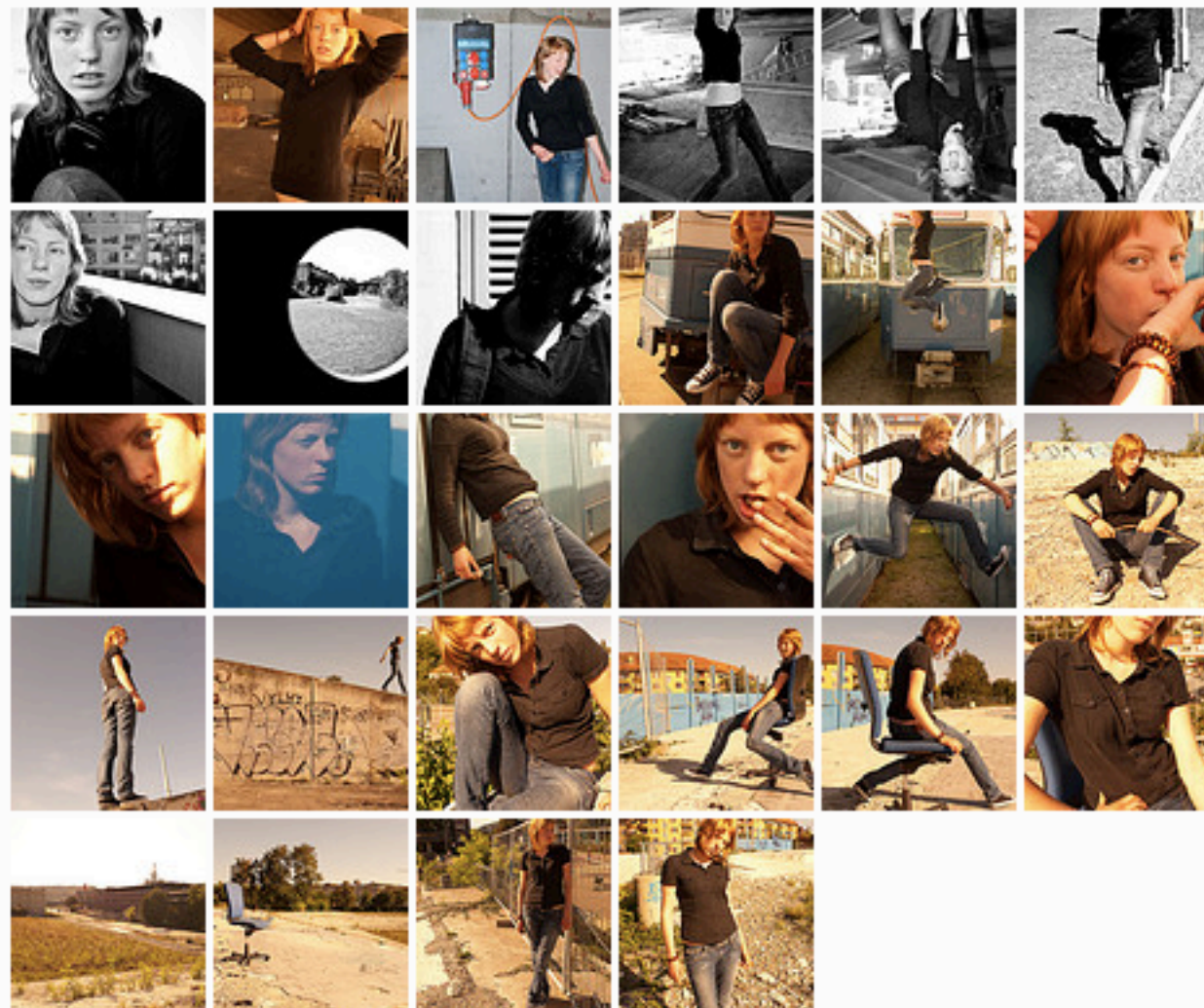
West, Switzerland (2009)

Thumbnails Detail Comments



28 photos | 134 views

items are from 06 Sep 2009.



```
$ curl 'http://api.flickr.com/services/rest/?
method=flickr.photosets.getPhotos&api_key=...
&photoset_id=72157622195851685'
```

```
<?xml version="1.0" encoding="utf-8" ?>
<rsp stat="ok">
  <photoset id="72157622195851685" primary="3903494313"
    owner="72389028@N00" ownername="Daniel Gasienica"
    page="1" per_page="500" pages="1" total="28">
    <photo id="3903494313" secret="ed13b44003"
      server="3463" farm="4" title="" isprimary="1" />
    <photo id="3904279566" secret="f856a3e70e"
      server="2473" farm="3" title="" isprimary="0" />
    <photo id="3904282048" secret="eec17c49e5"
      server="3533" farm="4" title="" isprimary="0" />
    ...
    <photo id="3904349418" secret="cf6c4b7b2c"
      server="2443" farm="3" title="" isprimary="0" />
  </photoset>
</rsp>
```

Web API Landscape

Bing, Google, Yahoo

Mapping

embed maps
(satellite, road, terrain)

pushpins

custom layers

3D models

Facebook

**events, comments, friends,
groups, links, messages, notes,
notifications, pages, photos,
profiles, SMS, stream, users,
video**

flickr

**activity, blogs, collections, contacts,
favorites, groups, pools, interestingness,
machine tags, panda, people, photos,
comments, geo, licenses, notes,
transform, upload, photosets, places,
preferences, tags, urls**

delicious

posts (bookmarks) & tags

friendfeed

**feeds, entries, search,
comments, urls, short urls,
themes**

twitter

statuses, trends, search, users,
lists, friendships, followers,
favorites, notifications

amazon

**customers, items (products),
(wish) lists, carts, sellers**

Google

**Analytics, Base, Apps, Blogger,
Booksearch, Calendar, Code Search,
Contacts, Documents, Finance, Health,
Maps, Picasa, Sidewiki, Sites,
Spreadsheets, Webmaster Tools,
YouTube**

data.gov

**population, taxes,
unemployment, pollution,
education, health care, military
spending, ...**

Mashups

[māsh'ŭp']

«[A] mashup is a web page or application that combines data or functionality from two or more external sources to create a new service.» – Wikipedia

Oakland Crimespotting

<http://oakland.crimespotting.org>

Oakland Crimespotting

Report data last published by Oakland Police: 2 days ago

Home Map Crime Reports Police Beats Alerts API About Feedback

Crime Watch Data + Virtual Earth Map Tiles

TIME OF DAY
Show All | Hide All
Light | Dark [nearest hour]
Commute | Nightlife
Day | Night | Swing Shift

DATE
Past Week
Nov 2009

OCT 12 2009 OCT 19 2009 OCT 26 2009 NOV 2 2009

M T W Th F S S M T W Th F S S M T W Th F S S

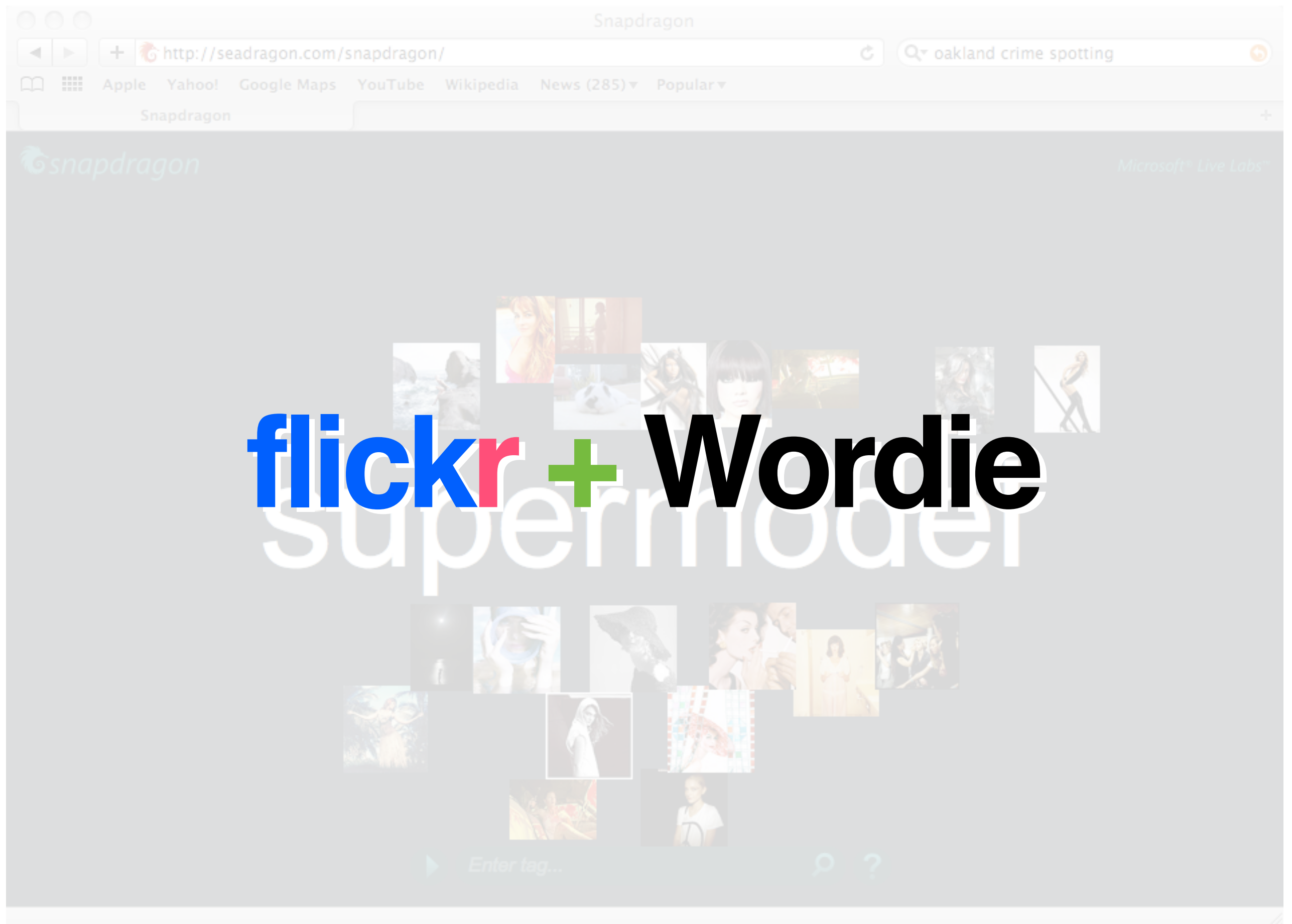
Map tiles © CloudMade. Map data CC-BY-SA OpenStreetMap.org

Notice anything different?
We've been working on the interface design, [read more about it on the blog.](#)

A note about map symbols

snapdragon

[**http://seadragon.com/snapdragon**](http://seadragon.com/snapdragon)



Front-ends & Data Visualizations

Newsmap

[**http://newsmap.jp**](http://newsmap.jp)

newsmap

◀▶

+

http://newsmap.jp/

RSS

↻

oakland crime spotting

Apple

Yahoo!

Google Maps

YouTube

Wikipedia

News (285)▼

Popular▼

newsmap

REGISTER

LOGIN

CUSTOMIZE

+ SELECT ALL

AR

AU

AU

BR

CA

FR

GE

IND

ITA

ME

NE

NE

SP

U.K

U.S

search all...

🔍

🗖

Case against soldier accused in mass shooting faces many hurdles

Fort Hood shooting suspect's ties to mosque investigated

Health bill faces battle in Senate

Healthcare bill faces tough path in Senate

Hurricane warnings for US Gulf Coast for Ida

OIL FUTURES: Crude Rises As Focus Turns To Hurricane Ida

Remembering the night the Berlin Wall fell

The Cowboys have a one-game lead on the Eagles at the midpoint of the season

Kurt Busch wins at Texas, Johnson 38th after wreck

Free flu clinic in city offers seasonal, H1N1 shots

School H1N1 clinics begin Monday

More than 120 die as storm hits El Salvador

Berlin Wall anniversary: escapees tell of night they fled to West by boat

Iraq to hold elections in January

Key election law passed

Josh Freeman guides Buccaneers to snap 11-game losing streak

49ers falter again

What the House Bill Would Mean for Various Groups

Health y move

Health Care Bill Recognizes Gay Partners

India limits media on contentious Dalai Lama trip

Africa: Giant Buys a Lamb

Gordon Brown criticized for not bowing at Cenotaph

Japan's Mixed Signals Add to Uncertainty Over U.S. Installations

Indonesia's quake kills one, wounds 88

Arrests in firework death inquiry

us, Al Qaeda Target Taliban Reaction

to the us News

Thailand's

Best and Worst of yesterday's Patriots game

Cubs escape with 20-17 win on Houston's late miss

Chris Green's holding penalty a backbreaker in Giants loss to Chargers

49ers game report

TCU waits for Baker, Tide or Horns to slip

Carl Alabama play Florida now?

Donovan comes through for Baker

First home loss of season for Patriots

Oilers hand Anaheim first home

What the House Bill Would Mean for Various Groups

Northrop Grumman to sell

Microsoft Battles Microsoft

Asian Stocks Rebound on A-20r

U.S., U.K. Split Over Bankruptcy

Health Care Bill Recognizes Gay Partners

Carrey's Carol tops US box office

Two cable networks merge

Taylor Swift

My First Weekend

PC Modern

My First Weekend

BETA FEEDBACK

newsmap

Mon November 9, 2009 2:08:37

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Google™

WORLD

NATIONAL

BUSINESS

TECHNOLOGY

SPORTS

ENTERTAINMENT

HEALTH

LESS THAN 10 MIN. AGO

MORE THAN 10 MIN. AGO

MORE THAN 1 HOUR AGO

Behind the Scenes

Disclaimer: Nitty-Gritty Details Inside

SOAP *vs* REST

Food for Thought

*Amazon AWS offers
both: SOAP & REST interfaces.
85% use REST.**

[sohp]

«SOAP is a lightweight protocol intended for exchanging structured information in a decentralized, distributed environment.» – W3C

SOAP

Successor to XML-RPC

XML-RPC Request

<http://api.flickr.com/services/xmlrpc/>

```
<methodCall>
  <methodName>flickr.test.echo</methodName>
  <params>
    <param>
      <value>
        <struct>
          <member>
            <name>name</name>
            <value><string>value</string></value>
          </member>
          <member>
            <name>foo</name>
            <value><string>bar</string></value>
          </member>
        </struct>
      </value>
    </param>
  </params>
</methodCall>
```

XML-RPC Response

```
<?xml version="1.0" encoding="utf-8" ?>
<methodResponse>
  <params>
    <param>
      <value>
        <string>
          &lt;method&gt;flickr.test.echo&lt;/method&gt;
          &lt;format&gt;xmlrpc&lt;/format&gt;
          &lt;name&gt;value&lt;/name&gt;&lt;foo&gt;bar&lt;/foo&gt;
          &lt;api_key&gt;54b5ce1d3cf75e92f9b8c50d353f3981&lt;/
          api_key&gt;
        </string>
      </value>
    </param>
  </params>
</methodResponse>
```

SOAP

Successor to XML-RPC

SOAP Request

<http://api.flickr.com/services/soap/>

```
<s:Envelope
  xmlns:s="http://www.w3.org/2003/05/soap-envelope"
  xmlns:xsi="http://www.w3.org/1999/XMLSchema-instance"
  xmlns:xsd="http://www.w3.org/1999/XMLSchema">
  <s:Body>
    <x:FlickrRequest xmlns:x="urn:flickr">
      <method>flickr.test.echo</method>
      <foo>bar</foo>
    </x:FlickrRequest>
  </s:Body>
</s:Envelope>
```

SOAP Response

```
<?xml version="1.0" encoding="utf-8" ?>
<s:Envelope
  xmlns:s="http://www.w3.org/2003/05/soap-envelope"
  xmlns:xsi="http://www.w3.org/1999/XMLSchema-instance"
  xmlns:xsd="http://www.w3.org/1999/XMLSchema">
  <s:Body>
    <x:FlickrResponse xmlns:x="urn:flickr">
      <method>flickr.test.echo</method>
      <format>soap</format>
      <foo>bar</foo>
      <api_key>54b5ce1d3cf75e92f9b8c50d353f3981</api_key>
    </x:FlickrResponse>
  </s:Body>
</s:Envelope>
```

SOAP

Successor to XML-RPC

Simple Object Access Protocol

SOAP

Successor to XML-RPC

Simple Object Access Protocol

WSDL

SOAP

Successor to XML-RPC

Simple Object Access Protocol

WSDL

UDDI

SOAP

Successor to XML-RPC

Simple Object Access Protocol

WSDL

UDDI

WS-Trust

WS-Discovery

SOAP

Successor to XML-RPC

Simple Object Access Protocol

WSDL

UDDI

WS-Trust

WS-Federation

WS-Policy

WS-Discovery

SOAP

Successor to XML-RPC

~~Simple~~ Object Access Protocol

WSDL

UDDI

WS-Trust

WS-Federation

WS-Policy

WS-Discovery

SOAP

Successor to XML-RPC

~~Simple Object~~ Access Protocol

WSDL

UDDI

WS-Trust

WS-Federation

WS-Policy

WS-Discovery

SOAP

Successor to XML-RPC

~~Simple Object Access Protocol~~

WSDL

UDDI

WS-Trust

WS-Federation

WS-Policy

WS-Discovery

SOAP

Successor to XML-RPC

~~Simple Object Access Protocol~~

WSDL

UDDI

WS-Trust

WS-Federation

WS-Policy

WS-Discovery

REST

Representational State Transfer

**Introduced as ‘architectural style’ in
Roy T. Fielding’s dissertation**

*Architectural Styles and
the Design of Network-based Software Architectures*

Roy T. Fielding

One of principal authors
of HTTP specification

Involved in development
of HTML and URIs

Co-founder of Apache HTTP Server
project and chair of Apache Software
foundation

REST: Theory

Client-Server

Stateless

Cacheable

Uniform Interface

Layered System

REST: Example

Resources (URIs)

List of Employees: www.livelabs.com/employees

Employee: www.livelabs.com/employees/t-dangas

List of Projects: www.livelabs.com/projects/

Project: www.livelabs.com/projects/seadragon

Team: www.livelabs.com/projects/seadragon/team

REST: Example

Resource

www.livelabs.com/employees/t-dangas

Representations

`image/jpeg`



`text/json`

```
{ "alias": "t-dangas",  
  "name": "Daniel Gasienica",  
  "position": "Intern" }
```

`application/xml`

```
<employee alias="t-dangas"  
  name="Daniel Gasienica"  
  position="Intern" />
```

REST: Example

CRUD Operations on Resources Using HTTP*

Create ≈ HTTP POST

Read ≈ HTTP GET

Update ≈ HTTP PUT

Delete ≈ HTTP DELETE

* simplification

REST

Safe

HTTP GET, ...

Idempotent

HTTP PUT, HTTP DELETE, ...

HTTP POST

REST: Example

Resource

www.livelabs.com/employees/t-dangas

Create (Request)

POST /employees HTTP/1.1

Host: www.livelabs.com

Content-Type: text/json

Content-Length: 56

Authorization: Basic

QWxhZGRpbjpvcGVuIHNlc2FtZQ==

```
{"alias": "t-dangas", "name": "Daniel  
Gasienica", "position": "Intern"}
```

or

PUT /employees/t-dangas HTTP/1.1

Host: www.livelabs.com

Content-Type: application/xml

Content-Length: 74

Authorization: Basic

QWxhZGRpbjpvcGVuIHNlc2FtZQ==

```
<employee alias="t-dangas"  
  name="Daniel Gasienica"  
  position="Intern" />
```

REST: Example

Resource

www.livelabs.com/employees/t-dangas

Create (Response)

HTTP/1.1 201 Created

Location:

[/employees/t-dangas](http://www.livelabs.com/employees/t-dangas)

Or

HTTP/1.1 200 Ok

NOT REST: Example

flickr: Create Photoset Request (HTTP **POST**)

```
http://api.flickr.com/services/rest/  
?method=flickr.photosets.create  
&api_key=...&auth_token=...&api_sig=...  
&title=WATCHAMACALLIT  
&description=Foo+%26+Bar  
&primary_photo_id=3961329953  
&format=xml
```


NOT REST: Example

flickr: Create Photoset Response

```
<rsp stat="ok">  
  <photoset id="72157622765502316"  
    url="http://www.flickr.com/photos/gasi/sets/  
72157622765502316/" />  
</rsp>
```

REST: Example

Resource

www.livelabs.com/employees/t-dangas

Read (Request)

GET /employees/t-dangas HTTP/1.1

Host: www.livelabs.com

Accept: application/xml

REST: Example

Resource

www.livelabs.com/employees/t-dangas

Read (Response)

HTTP/1.1 200 Ok

Content-Length: 74

Content-Type: application/xml

Expires: Fri, 8 Jan 2010 13:37:42 GMT

```
<employee alias="t-dangas"  
  name="Daniel Gasienica"  
  position="Intern" />
```

NOT REST: Example

flickr: Read Person Request (HTTP **GET**)

```
http://api.flickr.com/services/rest/  
?method=flickr.people.getInfo  
&api_key=...  
&user_id=72389028%40N00  
&format=xml
```

NOT REST: Example

flickr: Read Person Response

```
<rsp stat="ok">
  <person id="72389028@N00" nsid="72389028@N00"
    isadmin="0" ispro="1" ... path_alias="gasi">
    <username>Daniel Gasienica</username>
    <realname>Daniel Gasienica</realname>
    ...
  </person>
</rsp>
```

REST: Example

Resource

www.livelabs.com/employees/t-dangas

Update (Request)

PUT [/employees/t-dangas](http://www.livelabs.com/employees/t-dangas) HTTP/1.1

Host: www.livelabs.com

Content-Type: **text/json**

Content-Length: 59

```
{ "alias": "t-dangas", "name": "Daniel  
Gasienica", "position": "Senior VP" }
```

REST: Example

Resource

www.livelabs.com/employees/t-dangas

Update (Response)

HTTP/1.1 401 Not Authorized

NOT REST: Example

flickr: Update Photo Metadata

Request (HTTP **POST**)

```
http://api.flickr.com/services/rest/  
?method=flickr.photos.setMeta  
&api_key=...&auth_token=...&api_sig=...  
&title=Lady  
&description=Gaga  
&photo_id=3961329953
```


NOT REST: Example

flickr: Update Photo Metadata Response

```
<rsp stat="fail">  
  <err code="99" msg="Insufficient permissions. ↩  
Method requires write privileges; none granted." />  
</rsp>
```

REST: Example

Resource

www.livelabs.com/employees/billg

Delete (Request)

DELETE [/employees/billg](http://www.livelabs.com/employees/billg) HTTP/1.1

Host: www.livelabs.com

Authorization: Basic

QWxhZGRpbjpvcGVuIHNlc2FtZQ==

REST: Example

Resource

www.livelabs.com/employees/billg

Delete (Response)

HTTP/1.1 404 Not Found

NOT REST: Example

flickr: Delete Photo (HTTP **POST**)

```
http://api.flickr.com/services/rest/  
?method=flickr.photos.delete  
&api_key=...&auth_token=...&api_sig=...  
&photo_id=396132995323
```

NOT REST: Example

flickr: Delete Photo Response

```
<rsp stat="fail">  
  <err code="1" msg="Photo &quot;396132995323&quot;  
not found (invalid ID)" />  
</rsp>
```

REST: Lessons

**REST is a post-hoc description
of the architecture of the Web**

REST: Lessons

The Web is (mostly) REST!

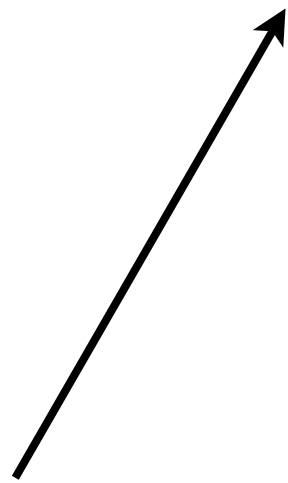
REST: Lessons

The Web is (mostly) REST!

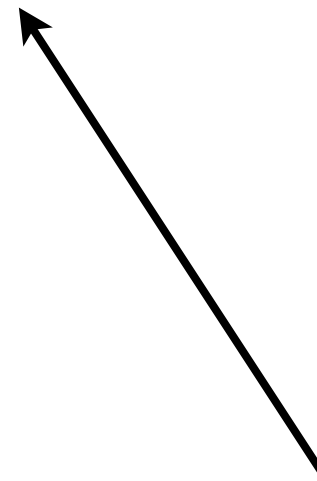
Don't reinvent the wheel!

Future

Semantic Web



Human Web



Machine Web

Semantic Web

«The Semantic Web is not a separate Web but an extension of the current one, in which information is given well-defined meaning, better enabling computers and people to work in cooperation.»

— «The Semantic Web» by Tim Berners-Lee, James Hendler, and Ora Lassila

Questions?

Further Reading

Mashups, APIs and the Web as Platform

www.programmableweb.com

Tim Berners-Lee on the next Web

www.ted.com/index.php/talks/tim_berners_lee_on_the_next_web.html

How I Explained REST to My Wife – Ryan Tomayko

www.tomayko.com/writings/rest-to-my-wife

Why SOAP sucks – Nelson Minar

www.somebits.com/weblog/tech/bad/whySoapSucks.html

Book



Backup

JSON

«JSON, short for JavaScript Object Notation, is a lightweight computer data interchange format. It is a text-based, human-readable format for representing simple data structures and associative arrays (called objects).»

— Wikipedia

JSON

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

XML

```
<Person firstName="John" lastName="Smith">
  <address>
    <streetAddress>21 2nd Street</streetAddress>
    <city>New York</city>
    <state>NY</state>
    <postalCode>10021</postalCode>
  </address>
  <phoneNumber type="home">212 555-1234</phoneNumber>
  <phoneNumber type="fax">646 555-4567</phoneNumber>
</Person>
```