Libraries, API's, Frameworks

- **browsers are not perfectly standardized**
- **DOM and CSS coding is messy and complicated**
- **web services are ever more complex**

- **how do we make it easy to create applications?**

- **libraries of common Javascript operations**

- **API's, often Javascript, to access services**

- **frameworks: development environments for integrated client & server programming**

From developer.yahoo.com

```
YAHOO.util.Connect = {
   _msxml_progid:[
      'MSXML2.XMLHTTP.5.0',
      'MSXML2.XMLHTTP.4.0',
      'MSXML2.XMLHTTP.3.0',
      'MSXML2.XMLHTTP',
      'Microsoft.XMLHTTP'
      ],
   createXhrObject:function(transactionId) {
      var obj,http;
      try {
         http = new XMLHttpRequest();
         obj = { conn:http, tId:transactionId };
      }
      catch(e) {
         for (var i=0; i<this._msxml_progid.length; ++i){
            try {
              http = new ActiveXObject(this._msxml_progid[i]);
              obj = { conn:http, tId:transactionId };
              break;
            }
            catch(e){}
         }
      }
      finally {
         return obj;
      }
   }, ...
```

Javascript libraries

- **library of Javascript functions that typically provides**
  - easier access to DOM
  - convenience functions for arrays, iterators, etc.
  - uniform interface to Ajax
  - visual effects like fading, flying, folding, ...
  - drag and drop
  - in-place editing
  - extensive set of widgets: calendar, slider, progress bar, tabs, ...

- **there are lots of such libraries**
  - jQuery, jQueryUI, Dojo, Yahoo User Interface (YUI), mooTools, Prototype / Scriptaculous, ...

- **see `http://code.google.com/apis/libraries/`**
  - single library for uniform access to ~10 Javascript libraries
  - experiment at **`http://code.google.com/apis/ajax/playground`**

Basic structure of Ajax code in browser

```
var req;
function geturl(s) {
   if (s.length > 1) {
      url = 'http://www.cs.princeton.edu/~bwk/phone3.cgi?' + s;
      loadXMLDoc(url);  // loads asynchronously
   }
}
function loadXMLDoc(url) {
   req = new XMLHttpRequest();
   if (req) {
      req.onreadystatechange = processReqChange;
      req.open("GET", url);
      req.send(null);
   }
}
function processReqChange() {
   if (req.readyState == 4) {    // completed request
      if (req.status == 200)       // successful
         show(req.responseText); // could be responseXML
   }
}
function show(s) {   // show whatever came back
   document.getElementById("place").innerHTML = s
}
```

jQuery example

```
<script>
   function geturl(s) {
      if (s.length > 1) {
         var url = 'http://www.cs.princeton.edu/
                                 ~bwk/phone3.cgi?' + s;
         $.get(url, function(res) {
            $('pre').empty().append(res);;
         });
      }
   }
</script>
<form name=phone>
Type here:
   <input type="text" id="pat" onkeyup='geturl(pat.value);'>
</form>
<pre id="place"></pre>
```

Debugging Javascript

- **it's hard**
- **use var declarations, check balanced quotes, braces, brackets, …**
- **in Chrome**
  - "wrench" / Tools / Javascript console
- **in Firefox**
  - Tools / Web developer / Web Console

- **use console.log to write debugging output**
  - like printf
  - much better than alert(…) for most things

Google maps API (version 3)

```
<style type="text/css">
  html { height: 100% }
  body { height: 100%; margin: 0px; padding: 0px }
  #map { height: 100% }
</style>
<script type="text/javascript"
    src="http://maps.google.com/maps/api/js?sensor=true">
</script>
<script type="text/javascript">
  function initialize() {
    var latlong = new google.maps.LatLng(40.34705, -74.65495);
    var opts = {
      zoom: 18, center: latlong,
      mapTypeId: google.maps.MapTypeId.HYBRID };
    var map = new google.maps.Map(document.getElementById("map"), opts);
    var marker = new google.maps.Marker({
      position: latlong, map: map, title:"You are here, more or less" });
  }

</script>
</head>
<body onload="initialize()">
  <div id="map" style="width:100%; height:100%"></div>
```

Web [Application] Frameworks

- **conventional approach to building a web service**
  - write ad hoc client code in HTML, CSS, Javascript, ... by hand
  - write ad hoc server code in [whatever] by hand
  - write ad hoc access to [whatever] database system
- **so well understood that it's almost mechanical**
- **web frameworks mechanize (parts of) this process**
- **lots of tradeoffs and choices**
  - what client and server language(s)
  - how web pages are generated
  - how web events are linked to server actions
  - how database access is organized (if at all)
- **can be a big win, but not always**
  - somewhat heavyweight
  - easy to lose track of what's going on in multiple layers of generated software
  - work well if your application fits their model, less well if it doesn't
- **examples:**
  - Ruby on Rails
  - Django
  - Google Web Toolkit
  - Zend (PHP), ASP.NET (C#, VB.NET), and many others

Django

- **by Adrian Holovaty and Jacob Kaplan-Moss** (released July 2005)

Django Reinhart, 1910-1953

- **a collection of Python scripts to**
- **create a new project / site**
  - generates Python scripts for settings, etc.
  - configuration info stored as Python lists
- **creat a new application within a project**
  - generates scaffolding/framework for models, views
- **run a development web server for local testing**
- **generate a database or build interface to an existing database**
- **provide a command-line interface to application**
- **create an administrative interface for the database**
- ...

Django web framework

- **write client code in HTML, CSS, Javascript, ...**
  - Django template language helps separate form from content
- **write server code in Python**
  - some of this is generated for you
- **write database access with Python library calls**
  - they are translated to SQL database commands

- **URLs on web page map mechanically to Python function calls**
  - regular expressions specify classes of URLs
  - URL received by server is matched against regular expressions
  - if a match is found, that identifies function to be called
    and arguments to be provided to the function

Conventional approach to building a web site

- **user interface, logic, database access are all mixed together**

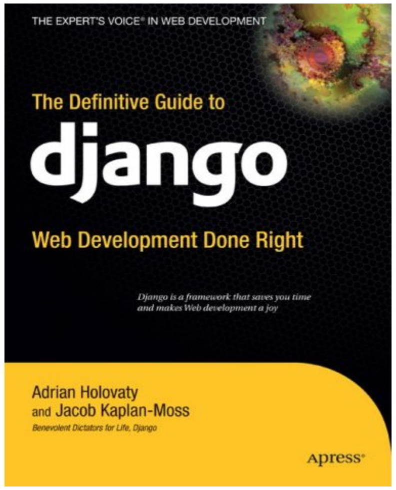
```
import MySQLdb
print "Content-Type: text/html"
print
print "<html><head><title>Books</title></head>"
print "<body>"
print "<h1>Books</h1>"
print "<ul>"
connection = MySQLdb.connect(user='me', passwd='x', db='my_db')
cursor = connection.cursor()
cursor.execute("SELECT name FROM books ORDER BY pub_date DESC")
for row in cursor.fetchall():
    print "<li>%s</li>" % row[0]
print "</ul>"
print "</body></html>"
connection.close()
```

Model-View-Controller (MVC) pattern

- **an example of a design pattern**
- **model: the structure of the data**
  - how data is defined and accessed
- **view: the user interface**
  - what it looks like on the screen
  - can have multiple views for one model
- **controller: how information is moved around**
  - processing events, gathering and processing data, generating HTML, ...
- **separate model from view from processing so that when one changes, the others need not**
- **used with varying fidelity in**
  - Django, App Engine, Ruby on Rails, XCode Interface Builder, ...
- **not always clear where to draw the lines**
  - but trying to separate concerns is good

Django approach

- **generate framework/skeleton of code by program**


THE EXPERT'S VOICE® IN WEB DEVELOPMENT
The Definitive Guide to
django
Web Development Done Right
Django is a framework that saves you time and makes Web development a joy
Adrian Holovaty
and Jacob Kaplan-Moss
Benevolent Dictators for Life, Django
Apress®

djangobook.com

```
# models.py (the database tables)

from django.db import models
class Book(models.Model):
  name = models.CharField(maxlength=50)
  pub_date = models.DateField()

# views.py (the business logic)
from django.shortcuts import render_to_response
from models import Book

def latest_books(request):
  book_list = Book.objects.order_by('-pub_date')[:10]
  return render_to_response('latest_books.html',
                             {'book_list': book_list})

# urls.py (the URL configuration)
from django.conf.urls.defaults import *
import views

urlpatterns = patterns('',
  (r'latest/$', views.latest_books),
)
```

Database linkage

in settings.py

```
DATABASES = {
   'default': {
       'ENGINE': 'django.db.backends.sqlite3',
       'NAME': '/Users/bwk/dj1/mysite/sql3.db', ...
```

in models.py

```
from django.db import models
class Books(models.Model):
   isbn = models.CharField(max_length=15)
   title = models.CharField(max_length=35)
   author = models.CharField(max_length=35)
   price = models.FloatField()
```

generated by Django

```
BEGIN;
CREATE TABLE "db1_books" (
    "id" integer NOT NULL PRIMARY KEY,
    "isbn" varchar(15) NOT NULL,
    "title" varchar(35) NOT NULL,
    "author" varchar(35) NOT NULL,
    "price" real NOT NULL
);
```

URL patterns

- **regular expressions used to recognize parameters and pass them to Python functions**
- **provides linkage between web page and what functions are called for semantic actions**

```
urlpatterns = patterns('',
   (r'^time/$', current_datetime),
   (r'^time/plus/(\d{1,2})/$', hours_ahead),
)
```

- **a reference to web page `time/` calls the function**

```
current_datetime()
```

- **tagged regular expressions for parameters: url `time/plus/12` calls the function**

```
hours_ahead(12)
```

Administrative interface

- **most systems need a way to modify the database even if initially created from bulk data**
  - add / remove users, set passwords, ...
  - add / remove records
  - fix contents of records
  - ...
- **often requires special code**
- **Django generates an administrative interface automatically**
  - loosely equivalent to MyPhpAdmin

```
urlpatterns = patterns('',
    ...
    # Uncomment this for admin:
    # (r'^admin/', include('django.contrib.admin.urls')),
```

Google Web Toolkit (GWT) (first available May 2006)

- **write client (browser) code in Java**
  - widgets, events, layout loosely similar to Swing
- **test client code on server side**
  - test browser, or plugin for testing with real browser on local system
- **compile Java to Javascript and HTML/CSS**
  - [once it works]
- **use generated code as part of a web page**
  - generated code is browser independent (diff versions for diff browsers)
- **can use development environments like Eclipse**
  - can use JUnit for testing
- **strong type checking on source**
  - detect typos, etc., at compile time (unlike Javascript)
- **doesn't handle all Java runtime libraries**
  - ?
- **no explicit support for database access on server**
  - use whatever package is available

"Same Origin Policy"

- **"The same origin policy prevents a document or script loaded from one origin from getting or setting properties of a document from another origin. This policy dates all the way back to Netscape Navigator 2.0." (Mozilla)**

- **"The SOP states that JavaScript code running on a web page may not interact with any resource not originating from the same web site." (Google)**

- **basically Javascript can only reference information from the site that provided the original code**

- **BUT: if a page loads Javascript from more than one site (e.g., as with cookies from third-party sites), then that JS code can interact with that third-party site**

GWT assessment

- problem: Javascript is irregular, unsafe, not portable, easily abused

- solution: use Java, which is type-safe, standard, portable
-
- translate Java to Javascript to either be browser independent
  or tailored to specific browser as appropriate
- can take advantage of browser quirks, make compact code,
  discourage reverse engineering
- can provide standardized mechanisms for widgets, events,
  DOM access, server access, AJAX, RE's and other libraries,
  ...

- in effect, treat each browser as a somewhat irregular machine and compile optimized code for it specifically

GWT vs Django

- **focusing on different parts of the overall problem**

- **GWT provides**
  - reliable, efficient, browser-independent Javascript (from Java)
  - extensive widget set
  - no help with database access, generating HTML, …

- **Django provides**
  - no Javascript help
  - no widgets
  - easy database access; template language for generating HTML, …
  - easy linkage from URLs on web page to Python functions

- **is GWT + App Engine a good combination?**

Assessment of Web Frameworks

- **advantages**
  - takes care of repetitive parts
    - more efficient in programmer time
  - automatically generated code is likely to be more reliable, have more uniformity of structure
  - "DRY" (don't repeat yourself) is encouraged
  - "single point of truth"
    - information is in only one place so it's easier to change things
  - ...
- **potential negatives**
  - automatically generated code
    - can be hard to figure out what's going on
    - can be hard to change if you don't want to do it their way
  - systems are large and can be slow
  - ...
- **read Joel Spolsky's "Why I hate frameworks"**

  `http://discuss.joelonsoftware.com/default.asp?joel.3.219431.12`

Assessment of Ajax-based systems

- **potential advantages**
  - can be much more responsive (cf Google maps)
  - can off-load work from server to client
  - code on server is not exposed
  - continuous update of services
- **potential negatives**
  - browsers are not standardized
  - Javascript code is exposed to client
  - Javascript code can be bulky and slow
  - asynchronous code can be tricky
  - DOM is very awkward
  - browser history not maintained without effort
- **what next? (changing fast)**
  - more and better libraries
  - better tools and languages for programming
  - better standardization?
  - will the browser ever replace the OS?