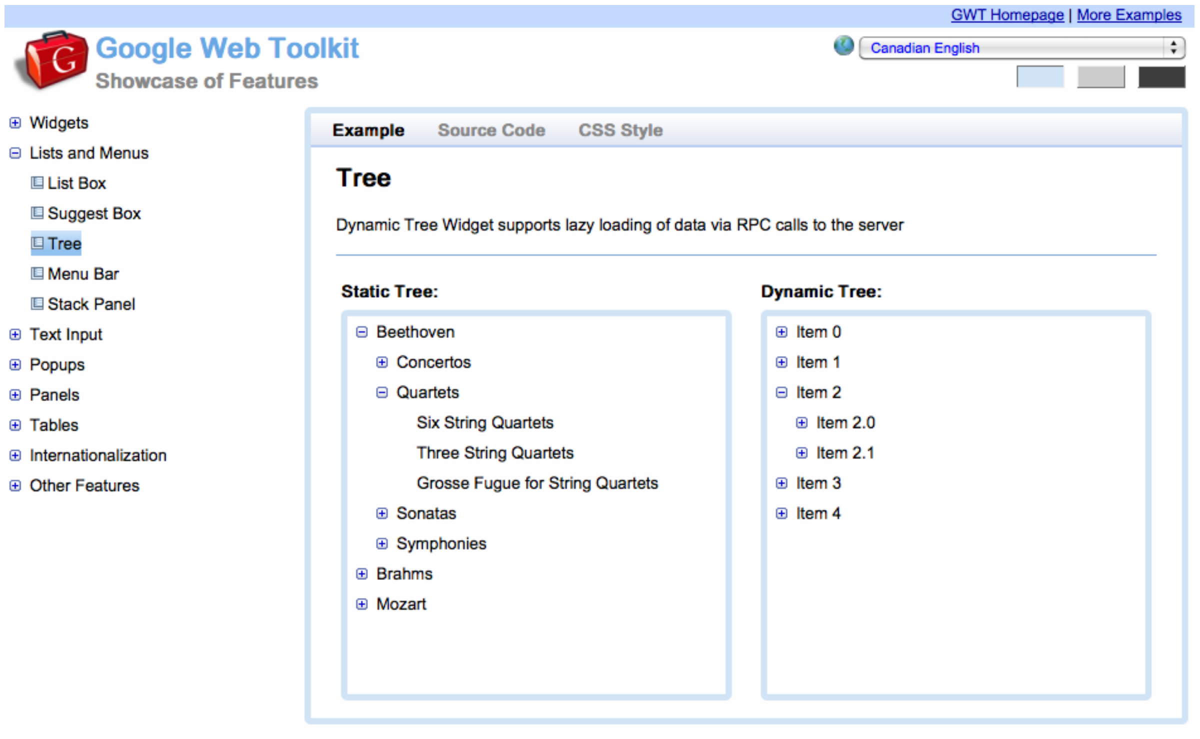
## Web [Application] Frameworks

- **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 lots of others [Wikipedia lists over 100]

## Google Web Toolkit (GWT) (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 normal HTML**
  - 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**
  - currently at Java version 1.5
- **no explicit support for database access on server**
  - use whatever package is available

## GWT Widgets



Tree

Dynamic Tree Widget supports lazy loading of data via RPC calls to the server

Static Tree:

- Beethoven
  - Concertos
  - Quartets
    - Six String Quartets
    - Three String Quartets
    - Grosse Fugue for String Quartets
  - Sonatas
  - Symphonies
- Brahms
- Mozart

Dynamic Tree:

- Item 0
- Item 1
- Item 2
  - Item 2.0
  - Item 2.1
- Item 3
- Item 4

## Java startup…

```
public class StockWatcher implements EntryPoint {
  private VerticalPanel mainPanel = new VerticalPanel();
  private FlexTable stocksFlexTable = new FlexTable();
  private HorizontalPanel addPanel = new HorizontalPanel();
  private TextBox newSymbolTextBox = new TextBox();
  private Button addStockButton = new Button("Add");
  private Label lastUpdatedLabel = new Label();
  private ArrayList<String> stocks = new ArrayList<String>();

public void onModuleLoad() {
    // Create table for stock data.
    stocksFlexTable.setText(0, 0, "Symbol");
    stocksFlexTable.setText(0, 1, "Price");
    stocksFlexTable.setText(0, 2, "Change");
    stocksFlexTable.setText(0, 3, "Remove");

    // Assemble Main panel.
    mainPanel.add(stocksFlexTable);
    mainPanel.add(addPanel);
    mainPanel.add(lastUpdatedLabel);
   ...
    // Associate the Main panel with the HTML host page.
    RootPanel.get("stockList").add(mainPanel);
```

## Linkage between Java/Javascript and HTML

```
<html>
  <head>
    <meta http-equiv="content-type" content="text/html; >
    <link type="text/css" rel="stylesheet"
          href="StockWatcher.css">
    <title>Brian's Portfolio</title>
    <script type="text/javascript" language="javascript"
       src="stockwatcher/stockwatcher.nocache.js"></script>
  </head>
  <body>
    <h1>Brian's Portfolio</h1>
    <div id="stockList"></div>
  </body>
</html>
```

## "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**

## Django

- **by Adrian Holovaty and Jacob Kaplan-Moss** (released July 2005)
- **a collection of Python scripts to**

Django Reinhart, 1910-1953

- **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()
```

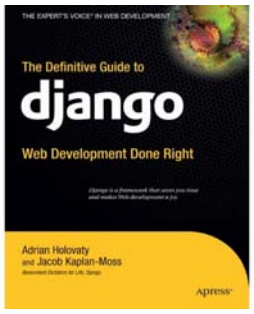
## Model-View-Controller (MVC) pattern

- **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**

```
# 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),
)
```


djangobook.com

## 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)`

## Templates for generating HTML

- try to separate page design from code that generates it
- Django has a specialized language for including HTML within code
  - loosely analogous to PHP mechanism

```
# latest_books.html (the template)

<html><head><title>Books</title></head>
<body>
<h1>Books</h1>
<ul>
{% for book in book_list %}
    <li>{{ book.name }}</li>
{% endfor %}
</ul>
</body></html>
```

## 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')),
```

## GWT vs Django

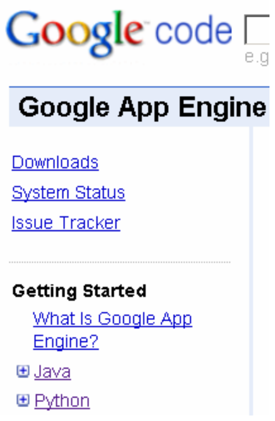
- **focusing on different parts of the overall problem**

- **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?**

## Google App Engine (since 4/08)



- **web application development framework**
  - analogous to Django
  - template mechanism looks the same
  - YAML for configuration
- **supports Python and Java on server side**
  - and other languages that use the Java Virtual Machine
- **Google provides the server**
- **restrictions on what server-side code can do**
  - non-relational database based on BigTable
  - only static files can be stored on the server, read only access
  - no sockets, threads, C-based modules, system calls, ...

```
application: helloworld
version: 1
runtime: python
api_version: 1

handlers:
- url: /.*
  script: helloworld.py
```

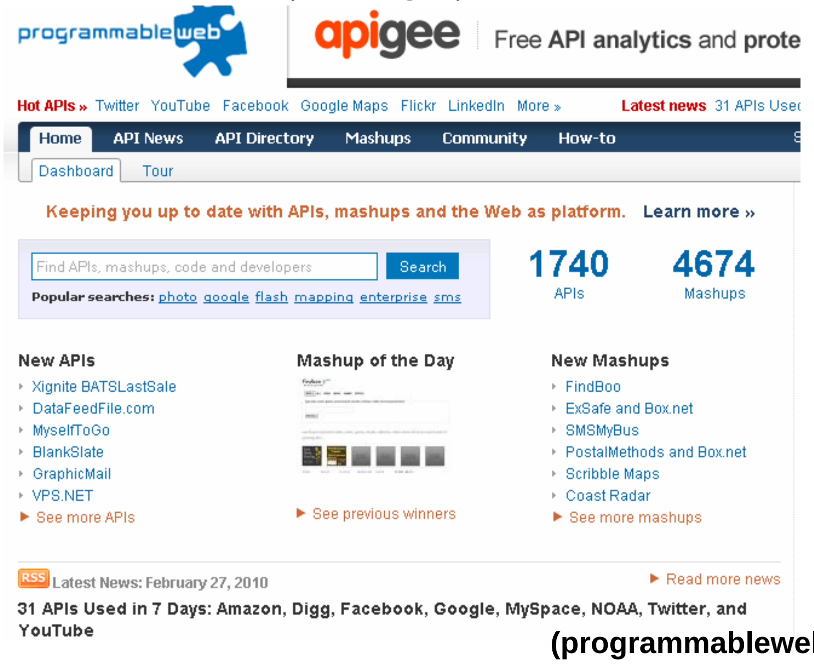
```
print 'Content-Type: text/plain'
print ''
print 'Hello, world!'
```

## 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 usually large and could be slow
  - ...
- **read Joel Spolsky's "Why I hate frameworks"**
  `http://discuss.joelonsoftware.com/default.asp?joel.3.219431.12`

## Mashups: duct tape programming

- **the web version of components?**
- **the browser as operating system?**



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**(programmableweb.com)**

## 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?