Lecture 10

[Web [Application]] Frameworks

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()
```

Overview of web application frameworks

- client-server relationship is stereotypical
  - client sends requests using information from forms
  - server parses request, calls proper function, which retrieves from database, formats response, returns it

- REST: URL filenames often used to encode requests

  …/login/name

  …/add/data_to_be_added

  …/delete/id_to_delete
- server uses URL pattern to call proper function with proper arguments

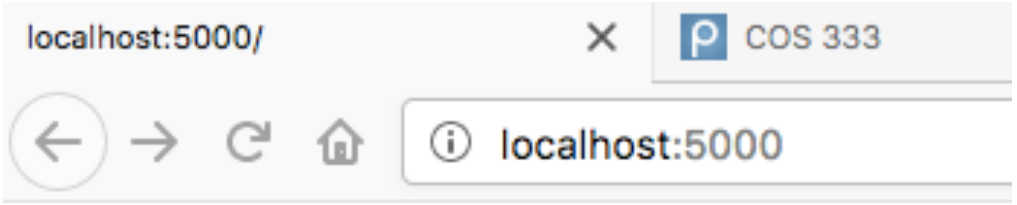
- server usually provides structured & safer access to database
- server may provide a templating language for generating HTML
  - e.g., replace `{% foo %}` with value of variable foo, etc.
- framework may automatically generate an administrative interface
- often provides library routines for user ids, passwords, registration, etc.

Flask: Python-based microframework

```
$ cat hello.py
    import flask
    app = flask.Flask(__name__)
    @app.route('/')
    def hello():
        return 'Hello world'
    app.run()
```

Armin Ronacher

```
$ python hello.py
```



Hello world

Sending form data

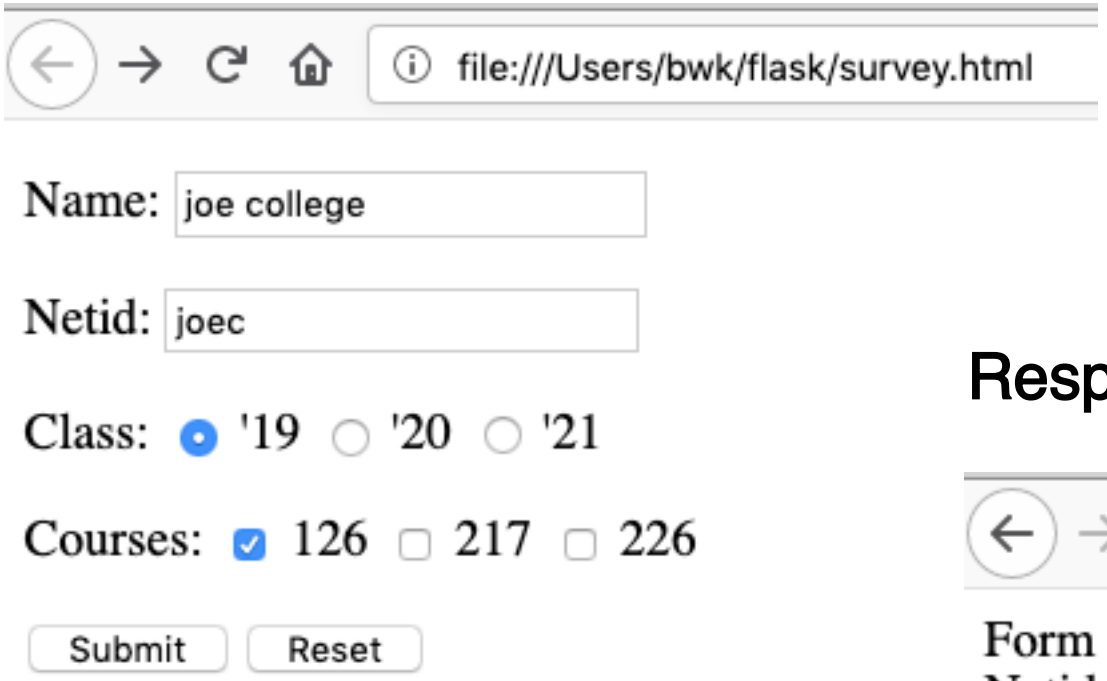
```
<html>
<title>Survey demo</title>
<body>
<form METHOD=POST ACTION="http://localhost:5000">
<p> Name: <input type="text" name=Name id=Name>
<p> Netid: <input type="text" name=Netid id=Netid>
<p> Class:
   <input type="radio" name=Class value="2019"> '19
   <input type="radio" name=Class value="2020"> '20
   <input type="radio" name=Class value="2021"> '21
<p> Courses:
   <input type="checkbox" name=C126> 126
   <input type="checkbox" name=C217> 217
   <input type="checkbox" name=C226> 226
<p> <input type="submit" value="Submit"> <input type=reset>
</form>
</body>
</html>
```

Processing form data

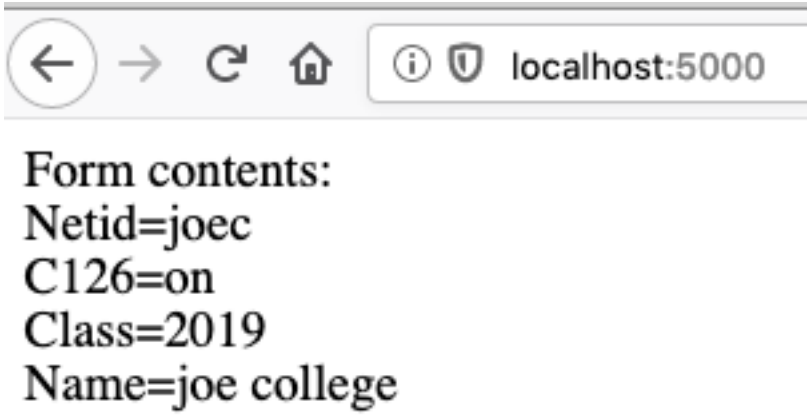
```
# survey.py

from flask import Flask, request

app = Flask(__name__)

@app.route('/', methods=['POST','GET'])
def survey():
    s = ""
    for (k,v) in request.form.iteritems():
        s = "%s %s=%s<br>" % (s, k, v)
    return 'Form contents:<br>' + s

app.run()
```

Flask interaction

Request:



Response:



Python @ decorators

- a way to insert or modify code in functions and classes

  ```
  @decorate
  function foo(): …
  ```

- compilation compiles `foo`, passes the object to `decorate`, which does something and replaces `foo` by the result
- used in Flask to manage URL routing

```
@app.route('/find/<str>')
def find(str):
    all = query_db('select * from lines')
    s = ''
    for i in all:
        if re.search(str, i[0]) != None:
            s = "%s%s\n" % (s, i[0])
    return '<pre>%s\n%s</pre>' % (str,  s)
```

Django: more heavyweight Python-based framework

- 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
- create 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
- run automated tests
- ...

Model-View-Controller (MVC) 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, ...

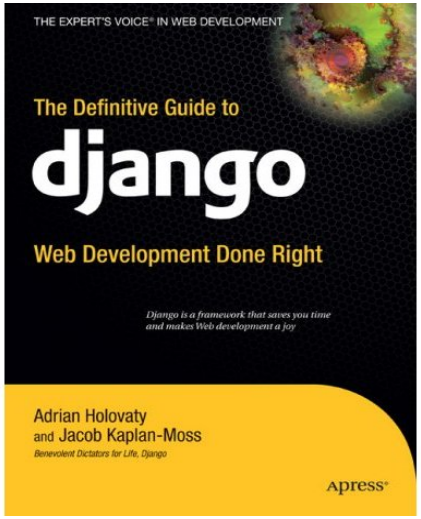
- separate model from view from processing so that when one part changes, the others need not

- used with varying fidelity in frameworks

- not always clear where to draw the lines
  - but trying to separate concerns is good

Django web framework

- write client code in HTML, CSS, Javascript, ...
  - Django template language helps to
    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



djangobook.com

- 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

Django automatically-generated files

- generate framework/skeleton of code by program

- three basic files:

  models.py: database tables, etc.

  views.py: business logic, formatting of output

  urls.py: linkage between web requests and view functions

- plus others for special purposes:

  settings.py: db type, names of modules, ...

  tests.py: test files

  admin.py: admin info

  templates: for generating and filling HTML info

Example database linkage

in settings.py

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

in models.py

```
from django.db import models
class Post(models.Model):
    title = models.TextField(5)
    text = models.TextField()
```

generated by Django

```
BEGIN;
CREATE TABLE "blog_post" (
    "id" integer NOT NULL PRIMARY KEY,
    "title" text NOT NULL,
    "text" text 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)`

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_posts.html (the template)

<html><head><title>Latest Posts</title></head>
<body>
<h1>Posts</h1>
<ul>
{% for post in post_list %}
    <li>{{ post.title }} {{ post.text }}</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

Alternatives…

- Ruby on Rails
- Google App Engine
- Node + Express
- and lots of others

Node.js server

```
var http = require('http');
http.createServer(function (req, res) {
  res.writeHead(200, {'Content-Type': 'text/plain'});
  res.end('Hello World\n');
}).listen(1337, '127.0.0.1');
```

- Express framework for Node
  - analogous to Flask

Express framework

```
var express = require('express')
var app = express()

app.get('/', function (req, res) {
  res.send('Hello World!')
})

app.listen(3000, function () {
  console.log('Example app listening on port 3000!')
})
```

Package managers

- pip Python (pypi.python.org/pypi/pip)

```
pip install Django
```

- apt-get Ubuntu Linux

```
apt-get install whatever
```

- npm Node.js (yarn is a wrapper around npm)

```
npm install node
```

- port Macports

```
port install ruby
```

- brew Homebrew

```
brew install ruby
```

- gem Ruby

- ...