## Dynamic Websites

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### Static and Dynamic Webpages

- ▶ Last week we built a **static** webpage, containing a single, fixed file and referencing other frozen resources (pictures).
  - Requesting that file's URL, we'll always see the same thing.
- ► Much of the web is **dynamic**: it evolves over time or as a function of its inputs, without someone literally rewriting the site.
  - ▶ N.B.: typically this means 'server side' dynamic: the server constructs the resource/site before sending it to you.
  - ► The individual resources (images, videos) in a site are usually static.
- ► Contrast to javascript (not covered), which can modify the page behavior or appearance as you click around (certain menus, web apps, formatting, etc.) and potentially request other resources.
  - ► Of course, those resources may be dynamic; e.g., gmail powered by AJAX (asynchronous javascript and XML, often actually JSON).

## The Options for Dynamic Websites

- ▶ 'Traditional' dynamic web stack is LAMP:
  - ► Linux + Apache + MySQL (DB) + php.
- ► Many more options today: other servers (nginx), databases (Postgres, SQLite) and languages (python, Ruby on Rails).
- ▶ We'll continue using python, with Django.
  - ► Popular, powerful framework, used by Instagram, Pinterest, The Onion, Washington Post, etc.
  - Want more? Exceptional tutorials: official and Django Girls.

### Web Server Gateway Interface

How do we 'hook up' python as a server?

- Server forwards requests to python through a 'gateway interface' module; python responds with a resource.
- Server should handle static resources itself (it's much better at it!); heavy server configuration is beyond the scope of this course.
- Luckily for us, Django provides a development server that is lightweight and easy to run.

**Python** Web Server Gateway Interface **Application Layer** Transport Layer Internet Layer Link Layer

#### What We'll Cover

Like python, a huge realm; choice of material and method very subjective.

- ▶ Initial set-up of django and a site.
- ► Create hello/goodbye world **views** and register its URLs.
- ▶ Return a **table** from pandas; the same, from csv.
- ▶ Build several very simple **dynamic** 'views.'
- ► Handling **GET** and **POST** data.
- ► An introduction to **forms**.
- ▶ Return a dynamic **plot** (v. generating 'all' the plots in advance).

These are basically the pieces you'll need to make your projects.

▶ On Wednesday, we'll make it pretty again, with HTML <u>templates</u> and hopefully a bit of bootstrap (pre-built css).

# Getting Started with Django: A Site

If you have not already done so, install django:

■ conda install django

Navigate to a directory where you want to work, then:

- django-admin startproject mysite
- cd mysite

Run the built-in development server, and check it out!!

■ python manage.py runserver

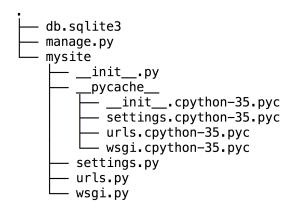
• • •

Django version 1.9.5, using settings 'mysite.settings' Starting development server at http://127.0.0.1:8000/Quit the server with CONTROL-C.

. . .

#### Site Resources

- ▶ This created a number of files for us.
- We've already run manage.py; we'll also use mysite/settings.py and mysite/urls.py a lot.

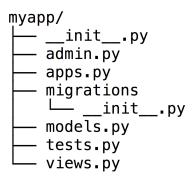


## Getting Started with Django: An App

A site is a collection of (potentially) many apps. Let's make one!

```
■ python manage.py startapp myapp
```

Just like startproject, this creates some files for us.



## Getting Started with Django: A view

- ▶ Views are specific functions/pages within an app.
- ▶ Edit the file myapp/views.py, adding these lines:

```
from django.http import HttpResponse

def index(request):
    return HttpResponse("Hello Harris!! A view!")
```

#### How Do We Find Our Site?

- Tell the site about the app. In mysite/urls.py, add:
  - ▶ from django.conf.urls import include
  - ▶ url(r'^myapp/', include('myapp.urls')),
- 2. Tell the app about the view. In myapp/urls.py, put

```
from django.conf.urls import url
from .import views

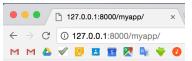
app_name = 'myapp'
urlpatterns = [
  url(r'^$', views.index, name='index'),
]
```

These are regular expressions, peeling off parts of the URL.

#### Now Run the Web Server Again:

■ python manage.py runserver

#### http://127.0.0.1:8000/myapp/



Hello Harris!! A view!

#### Let's Recap

- 1. Created a site with django-admin startproject.
- 2. Created an app with python manage.py startapp myapp.
- 3. Added a view to that app, which returned an HttpResponse.
- 4. Hooked up the urls.py for the site and app, to create the URL.
- 5. Have a site online!!

- ▶ Normally, we just create and register individual views.
- ▶ Let's make a 'farewell world' view (prepared for Wednesday!).

## Using What We've Already Learned

Run functions on a website, leveraging the awesome power of python!

▶ Let's make a pandas table, and use df.to\_html().

### Loading Static Data

- ▶ With Django, it's easy to make dynamic sites. Unfortunately, using static data is a bit of a pain.\*
- ▶ You will need to load CSV files for your homework and projets.

```
from os.path import join
from django.conf import settings
import pandas as pd

def csv(request):
   baby = join(settings.STATIC_ROOT, 'myapp/baby.csv')
   df = pd.read_csv(baby)
```

return HttpResponse(df.to\_html())

<sup>\*</sup>Django has extraordinary database support with Object-Relational Mapping (a different interface to RDBMSs). If you loaded all your data into your database, this would be the way to go.

#### Collecting Your Static Files

- ► Let's make a small csv at myapp/static/myapp/va\_presidential.csv.
- ▶ You also need to tell Django where your static files live.
- ▶ Set up the static files ROOT, in mysite/settings:
  - ► Add 'myapp.apps.MyappConfig' to INSTALLED\_APPS.
  - ► At the end, add STATIC\_ROOT = os.path.join(BASE\_DIR, 'static')
- ► Then run this (and accept):
  - python manage.py collectstatic
- We used the 'long' path, so that the 'collected' files would still have a recognizable pattern.

# **Dynamic Websites**

## Dynamic Websites: What's so great about Django?

- ► Strip variables out, in urls.py: this creates 'w':
  url(r'^greet/(?P<w>[A-Za-z\-]+)/\$', views.greet)
- ► Pass these to views:

```
def greet(request, w):
    return HttpResponse("Well hello, {}!".format(w))
```

▶ Let's create views to add and subtract numbers.

# **Templates**

git clone git@github.com:harris-ippp/django-ex.git

### What are Templates?

- ► Templates are reusable HTML code blocks, with insertion points for variables (or other large blocks), simple functions, and loops.
  - ► This reduces rewriting code (nav bar) and repetitive code (lists).
  - ▶ Philosophy: Don't Repeat Yourself (DRY).
- ► Template files live at myapp/templates/ex.html.
- 'Render' html code by inserting variables into the template by: return render(req, "ex.html", {"key": value})
- ▶ This is actually an HttpResponse.
- ▶ Best illustrated by example.

### Prettifying and Codifying: Templates

- ▶ Let's start by using templates to insert values.
- ▶ Good to use variables, but also want to reuse e.g., nav bar.
- ▶ So we could write our greeting with a view, like this:

```
from django.shortcuts import render

def greet_template(req, w):
    return render(req, "greet.html", {'who' : w})
```

► And a myapp/templates/greet.html as:

```
Well hello, {{ who }}!!
```

▶ Here, {{ who }} is variable, passed as an item in a dictionary.

#### Template Code: for, if

- Write for loops or if statements with:
  - ▶ {% for x in xli %}{{ x }}{% endfor %}
  - ► {% if animal == "dog" %}ARFF{% endif %}
- ▶ Let's create a view that renders a pure\_template.html.
- ▶ This is very useful for elements in parts of forms, etc.

#### Template Code: Dictionary and List Items, Functions

- ► For functions, drop the parentheses.
  - ► For instance {% for k, v in di.items %} (instead of di.items()
- Access variables out of a dictionary or elements of a list using a dot, instead of brackets.
  - ► So: di.cat instead of di["cat"].
- ► Still with pure\_template.html, let's render the dictionary,
  'di': {"dog":"ARF", "cat":"MEOW", "tiger":"ROAR"}

#### Template Inheritance

- ▶ I've copied my 'standard' header in myapp/templates/base.html.
  - ► The header will be reused every time.
- ▶ {% block content %} is a replaceable block of code.
- Swap it out by overwriting the bock, in myapp/templates/view\_table.html.

```
{% extends "base.html" %}

{% block content %}
  {{ html_table | safe }}
  {% lorem 3 p %} <!-- some text -->
{% endblock %}
```

- ▶ New view: render table, using html\_table and view\_table.html.
- Very little html, to get a new page.

#### Additional Template Functions

- ▶ To load css files, scripts, or other static files, you may need:
  - ▶ {% load staticfiles %} and {% static 'myapp/style.css' %}.
  - ▶ The latter locates a static file, according to your static ROOT.
- ► There are many, many template filters, most notably, 'safe,' which just prints to html (instead of wrapping it as a string).
  - ► You've seen {{ table\_html | safe }}.

# **Forms**

#### Reading GET and POST

- You don't want users to have to edit the URL.
- ► The first step to fixing this is to be able to read the GET and POST requests that your website would send.
- ▶ This is pretty easy (and it is the same for POST):

```
def get_reader(request): # note: no other params.

# if we knew the parameters...
# state = request.GET.get('state', '')

d = dict(request.GET._iterlists())
return HttpResponse(str(d))
```

► So how do we send this data?

#### **HTML Forms**

- ► The standard HTML element for inputing data is a <u>form</u>: a collection of radio buttons, check boxes, text input fields of varying lengths, drop-down menus, etc. within <form></form> tags. Two important attributes:
  - 1. action: destination site.
  - 2. method: get or post.
- ► Take a look at the source for this form:

https://harris-ippp.github.io/lectures/form.html

### HTML Forms and Django Models

- ▶ Django recognizes that there is likely a correspondence between data (objects/databases), forms (for creating objects), and views (for displaying them). They are all built from Models.
  - ▶ We won't cover this in depth the databases are implemented with an Object Relational-Mapping (ORM, RDBMS interface wrapping SQL) that would be a good deal more work.
  - ► But you can learn more <u>here</u>.
- ▶ Nevertheless, Models are a useful tool.
  - ▶ Instead of manually writing each form, you can create a Django object that will do (a lot of) the work for you.

#### A Minimal Model

Imagine that we want a drop-down selection of US states.

- ▶ Many types (CharField, IntegerField, &c.) and display methods.
- Create a model inheriting from django.forms.ModelForm in myapp/models.py:

#### A Minimal Form

Now writing the form is not so bad (but not intuitive, either).

▶ The attrs is for the html rendering of the element.

```
from
     django import forms
from
     .models import Input, STATES
class InputForm(forms.ModelForm):
  attrs = { 'class' : 'form—control',
           'onchange' : 'this.form.submit()'}
  state = forms.ChoiceField(choices=STATES, required=True,
                             widget=forms.Select(attrs = attrs))
  class Meta:
      model = Input
      fields = [ state 1
```

#### A Template: Display a Chosen State and an Option

► The elements of the form are 'automatically' by .as\_p or .as\_table, but the wrapping tags are not – they must be written out in the template.

```
{% if state %}
    I hear you, {{ state }}!!
{% endif %}

<form action="{{ form_action }}"
    method="{{ form_method }}">
    {{ form.as_p }}
</form>
```

#### A View

- ▶ We can pass all of the elements in the form to the template.
- ► Also use reverse\_lazy() to look up the url of the site.

```
from
     django.core.urlresolvers import reverse_lazy
     django.views.generic import FormView
from
from
     .forms import InputForm
def form(request):
    state = request.GET.get('state', 'PA') # PA = default
    params = { 'form_action' : reverse_lazy('myapp:form'),
               'form_method' : 'get',
              'form' : InputForm({'state' : state}),
              'state' : STATES_DICT[state]}
    return render(request, 'form.html', params)
```

#### Dynamic Plots

Make and return plots on the fly. (Brilliant or misguided?)

- ► Each visitor wants a plot with specific parameters. Can't put them all in the same place (overwrite), but can't save them all, either (space).
- ▶ On the other hand, most of what you generate will be the ~same. Making new plots for every single visitor is expensive.
- Depending on the parameters of your website, could generate 'all' possibilities and serve them statically. Faster but less flexible.

Other libraries (Bokeh) build plots with javascript from data... a good 'extension' in your projects.

### Creating Plots on the Fly: A Recipe

Looks like a lot, but just two tricks:

- 1. Write to bytes instead of a file.
- 2. Return the bytes as content\_type = "image/png".

```
import matplotlib.pyplot as plt, numpy as np
def pic(request, c = "k"):
    t = np.linspace(0, 2 * np.pi, 30)
    u = np.sin(t)
    plt.figure() # needed to avoid adding curves in plot
    plt.plot(t, u, color = c)
    # write bytes instead of file.
    from io import BytesIO
    figfile = BytesIO()
    # this is where the color is used.
    trv: plt.savefig(figfile, format='png')
    except ValueError: raise Http404("No such color")
    figfile.seek(0) # rewind to beginning of file
    return HttpResponse(figfile.read(), content type="image/png")
```