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).

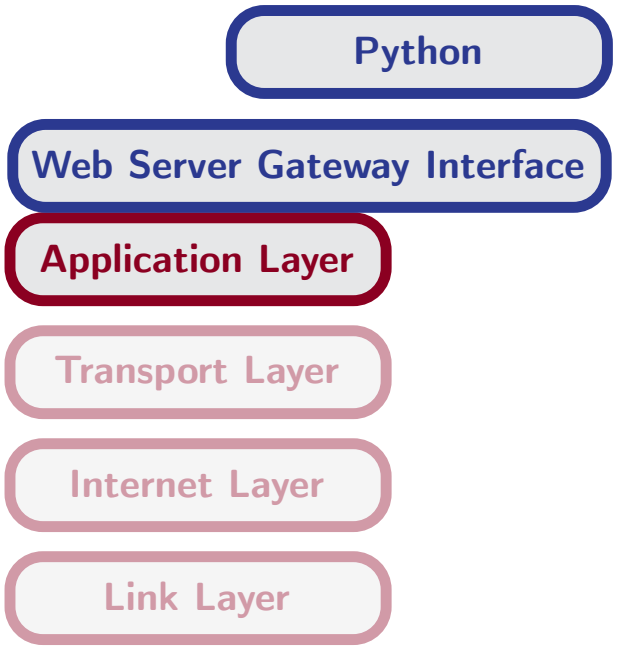
The Options for Dynamic Websites

- '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? Best tutorials I've ever seen: **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 very lightweight and easy to run.



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 templates 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.

```
.
├── db.sqlite3
├── manage.py
└── mysite
    ├── __init__.py
    ├── __pycache__
    │   ├── __init__.cpython-35.pyc
    │   ├── settings.cpython-35.pyc
    │   ├── urls.cpython-35.pyc
    │   └── wsgi.cpython-35.pyc
    ├── settings.py
    ├── urls.py
    └── wsgi.py
```

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.

```
myapp/
├── __init__.py
├── admin.py
├── apps.py
├── migrations
│   └── __init__.py
├── models.py
├── tests.py
└── views.py
```

Getting Started with Django: A view

Now 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?

1. 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

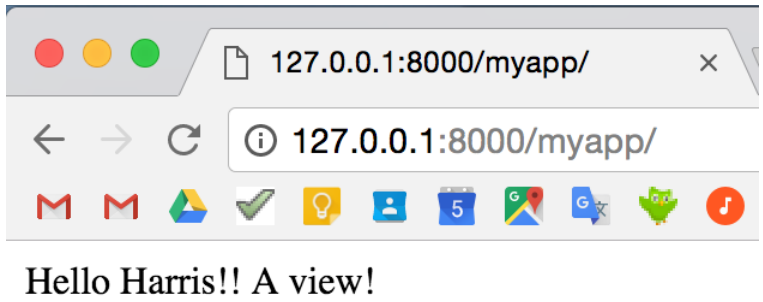
```
from  django.conf.urls import  url
from  . import  views

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/



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()`.

```
import pandas as pd, numpy as np

def table(request):

    df = pd.DataFrame(np.random.randn(10, 5),
                      columns = list("abcde"))

    table = df.to_html()

    return HttpResponse(table)
```

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())
```

*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/baby.csv`.
- You also need to tell Django where your static files live.
- Set up the static files ROOT, in mysite/settings:
  `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.

Beginning to Prettify: Templates

- **Templates** allow you to 'fill in' holes in websites.
- 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 }}!!
```

- We'll cover this in more detail on Wednesday.

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?

Forms

HTML Forms

- The standard HTML element for inputing data is a form: a collection of radio buttons, check boxes, text input fields of varying lengths, drop-down menus, etc. within `<form></form>` tags.
- Take a look at the source for this simple 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 **here**.
- 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`:

```
from  django.db import  models

# Create your models here.
STATES = ( ('AK', 'Alaska'), ('AL', 'Alabama'), # ...
           ('WV', 'West Virginia'), ('WY', 'Wyoming'))

class Input(models.Model): # our model inherits from  Django.
  state = models.CharField(max_length=2, choices=STATES)
  name  = models.CharField(max_length=50)
```

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']
```

A View

```
from  django.views.generic import  FormView
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)
```

Which Requires a Template

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

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

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 $\sim$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...

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.
    try: 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")
```