From 0 to DIY Web App in 120 minutes

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Outline

When you should not use this

- Static web site → static HTML and CSS.
- User-editable content — blog/corporate website → Content Managment System
- Data driven and highly structured data, well understood system based around Create Retrieve Update Delete (CRUD) → e.g. Django

When you should use this

- Something requiring persistent storage but where the data is not highly structured, or has a frequently changing schema or is otherwise difficult to reduce to a relational database $\rightarrow$ a non-relational database (NoSQL): e.g. MongoDB
- Something so small that setting up something like Django will take longer than actually implementing the functionality $\rightarrow$ a micro-framework, e.g. Bottle

Start thinking...

- There's no set end product for this workshop. There will be several spots where you can decide for yourself what to do, and get assistance in making it happen.
- Start thinking about a (relatively) simple application that (preferably) fits the previous critera, or at least is dynamic with persistent storage. Perhaps:
  - Collate information from a variety of internet-connected sensors, process it, and display a result. (e.g. average/min/max?)
  - A database of quotable quotes, with up/down-voting
  - Configurable Insult/3 word slogan/etc generator
  - Your idea here.
  - Really stuck? (Yet another) blog with comments, photo-sharing service, todo list, calendar, social-bookmarking service, etc. (Most of these things are better built with e.g. Django)

Get on the internet

- Get on the internet.
- Go to
  `http://dja.compcon.dja.id.au/static/presentation.pdf`
  to get these instructions so you can follow along at your own pace!

Local environment

- Set up git to point this to your repository, not mine.
  - Fork the repo on GitHub.
  - `git remote set-url origin https://github.com/`*`YOU`*`/diy-web-app`
  - (Unless you already have private keys set up, in which case use `git@github.com:`*`YOU`*`/diy-web-app.git`)
- `vagrant up`
- `vagrant ssh`
- Any changes you make to your local file system are reflected in the virtual machine in the `/vagrant` directory.

Remote environment

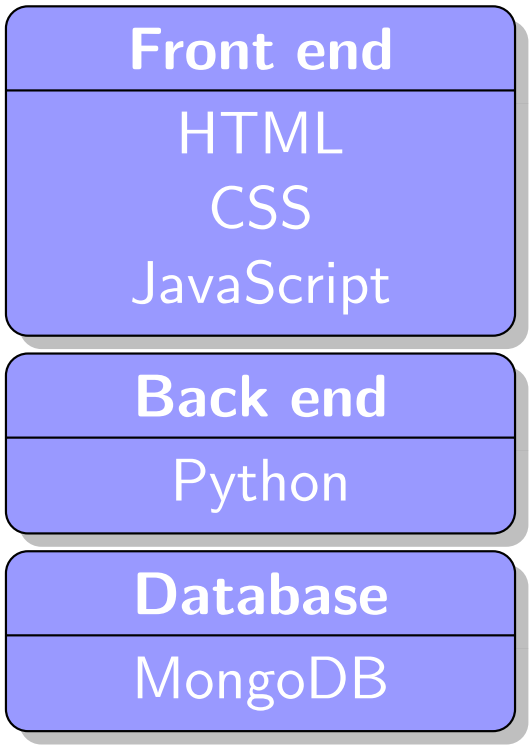
- You get a week of EC2 time on AWS to build/experiment with your app.
- AWS (Amazon Web Services) → a set of services.
  - EC2 - Elastic Cloud Compute → Virtual Machines
  - SES - Simple Email Service
  - Route 53 - DNS service → maps names like google.com to IP addresses like 203.8.182.219
  - S3 - Simple Storage Service → Way to store static assets/files.
  - CloudFront - CDN (Content Delivery Network) → caches static assets near the user for faster speed, less load on your server.
  - And many, many more.
- Not free in general, but a free tier exists.

Remote Environment

- You should have a bit of paper with the details of your EC2 instance.
- Follow those instructions. You should end up with a shell on your EC2 instance.
- Update the package lists and packages: `sudo apt-get update; sudo apt-get -y upgrade; sudo reboot`
- SSH in again after it reboots.

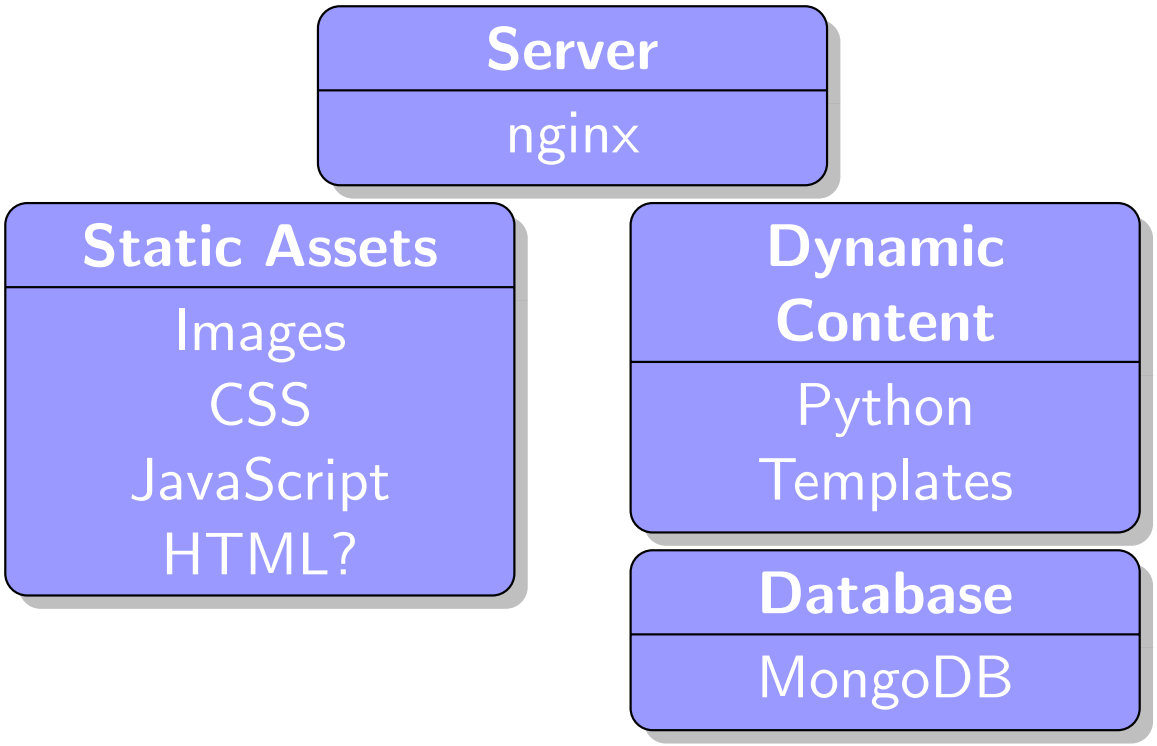
Anatomy of a simple web app: overview

Anatomy of a simple web app: now add a database



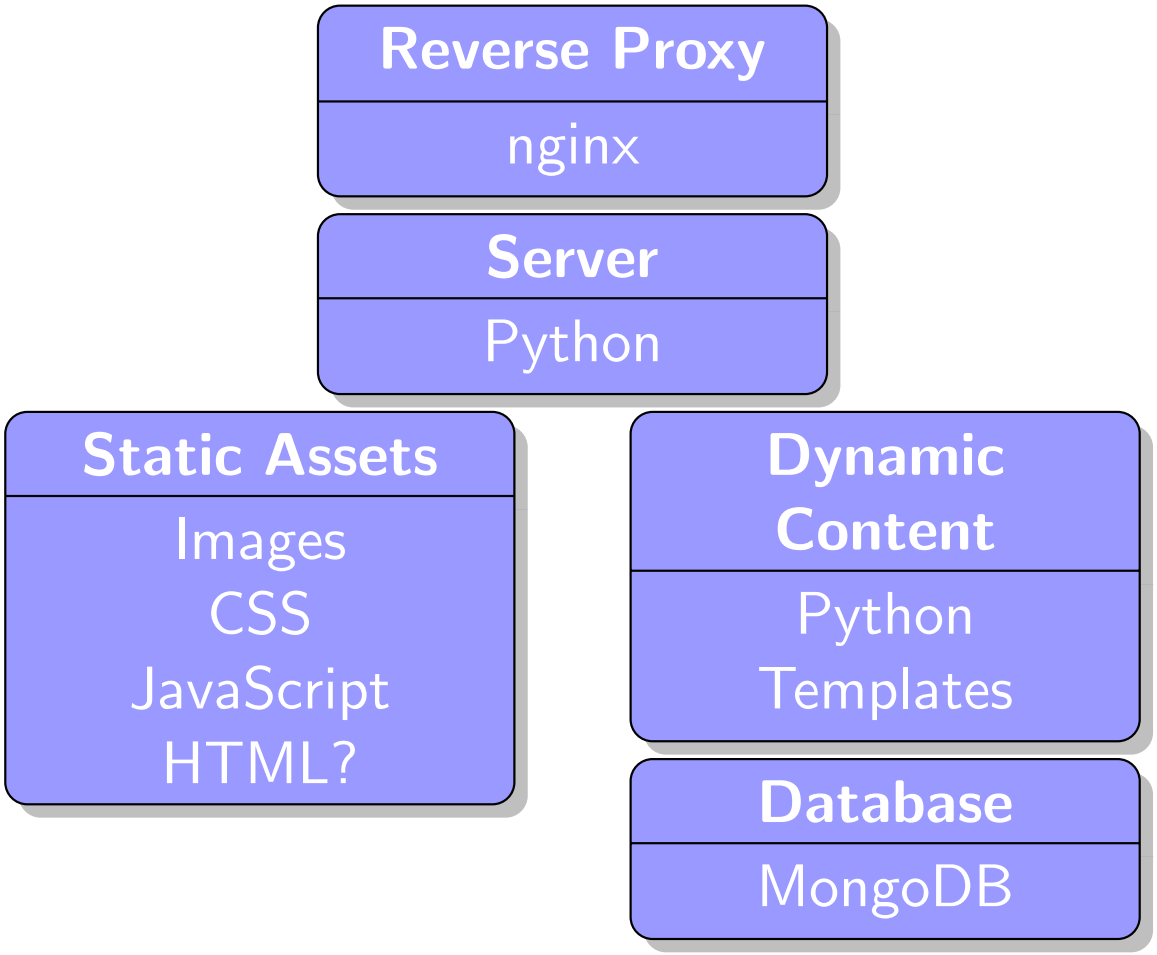
Anatomy of a simple web app: how does this get to you?

Ideal world



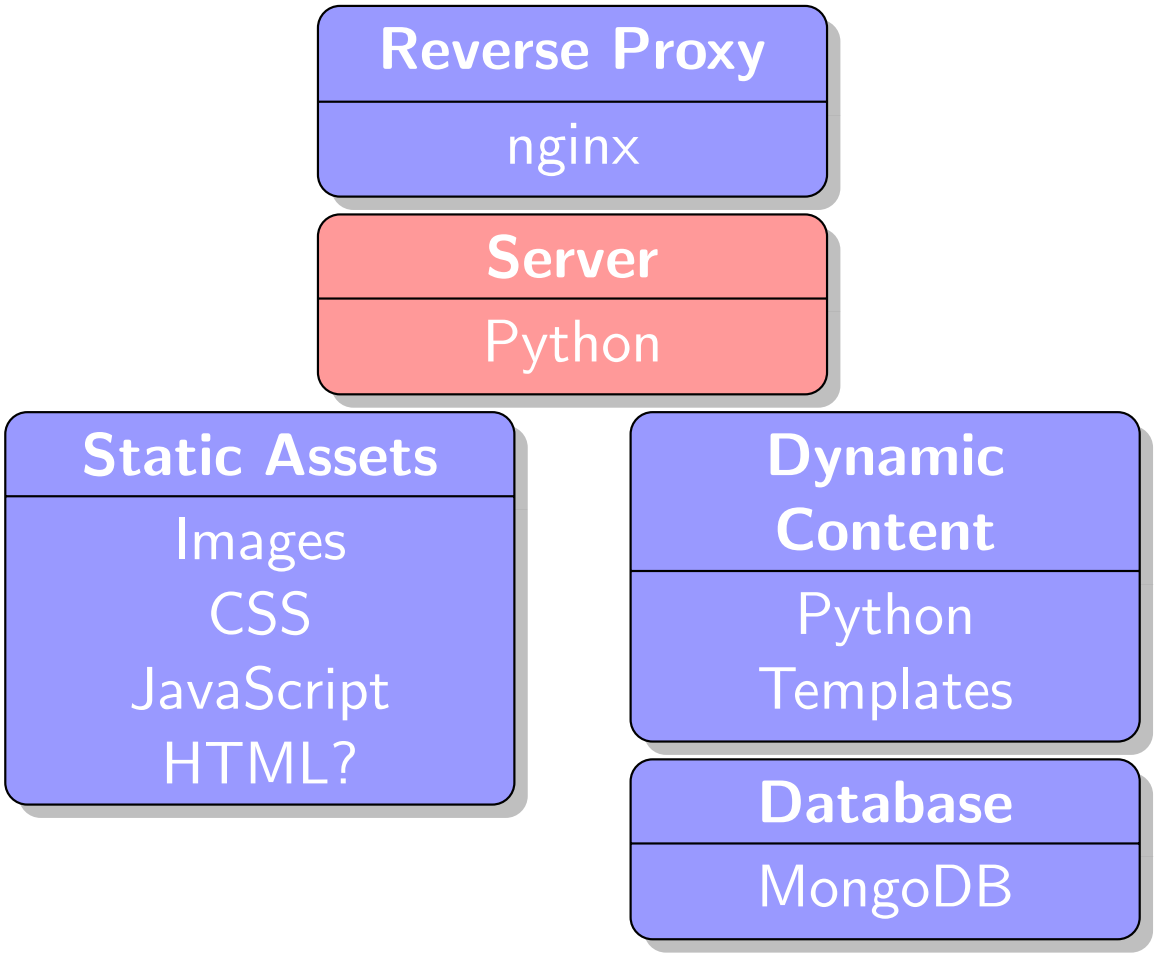
Anatomy of a simple web app: how does this get to you?

Our world



Building your app

Server


Reverse Proxy
nginx
Server
Python
Static Assets
Images
CSS
JavaScript
HTML?
Dynamic Content
Python
Templates
Database
MongoDB

Introducing Bottle

Figure : Bottle is a fast, simple and lightweight WSGI micro web-framework for Python. `http://bottlepy.org/`

You might also want to consider Flask: `http://flask.pocoo.org/`. It does a bit more for you/has a bit more magic than Bottle.

Hello World!

Edit `webapp.py`.

```
from bottle import route, run

@route('/')
def index():
        return "Hello World!"


if __name__ == '__main__':
        run(debug=True, reloader=True, host='0.0.0.0')
```

In your vagrant shell, `cd /vagrant; python webapp.py`.
Then visit `http://localhost:8080` in your browser.

Best practices: commit your changes!

```
git add webapp.py
git commit -m"Hello world example"
git push
```

Greeting others

Let's extend:

```
@route('/greet/<name>')
def greet(name):
    return "Hello, %s!" % name
```

```
git add webapp.py
git commit -m"Add greet function"
git push
```

Danger, Will Robinson!

Spot the subtle error and potential security hole.

Danger, Will Robinson!

What happens if you go to `localhost:8080/greet/<b>Daniel`?
This unescaped HTML has the potential (in other circumstances) to cause XSS vulnerabilites.
Fortunately, it's easy to avoid.

Safe user input the right way

Don't try to sanitise it yourself.
You will probably miss an edge case.

Use templates.

```
from bottle import route, run, template

...

def greet(name):
 return template("Hello, {{name}}!", name=name)
```

Separating presentation and content

We don't want template code in `.py` files.

Edit `views/hello.tpl`. Fill it with standard HTML, with `{{name}}` somewhere. (Lazy? See the link to the sample on the notes.)

Then:

```
from bottle import route, run, template, view

...

@route('/greet/<name>')
@view('hello')
def greet(name):
 return {'name': name}
```

Bottle's template language (SimpleTemplate Engine) has more features, which we'll cover later...

Simplifying things

Why do we have different functions for / and /greet, when they do mostly the same thing? **A bottle function can handle multiple routes.**

```
@route('/')
@route('/greet/<name>')
@view('hello')
def greet(name="World"):
```

Best practices: commit your changes!

```
git add webapp.py views/hello.tpl
git commit -m"Serve Hello World with a template."
git push
```

Serving static files

Put them in a separate sub-directory!

```
from bottle import route, run, template, view, static_file
import os

root = os.path.dirname(__file__)
static_root = os.path.join(root, "static")

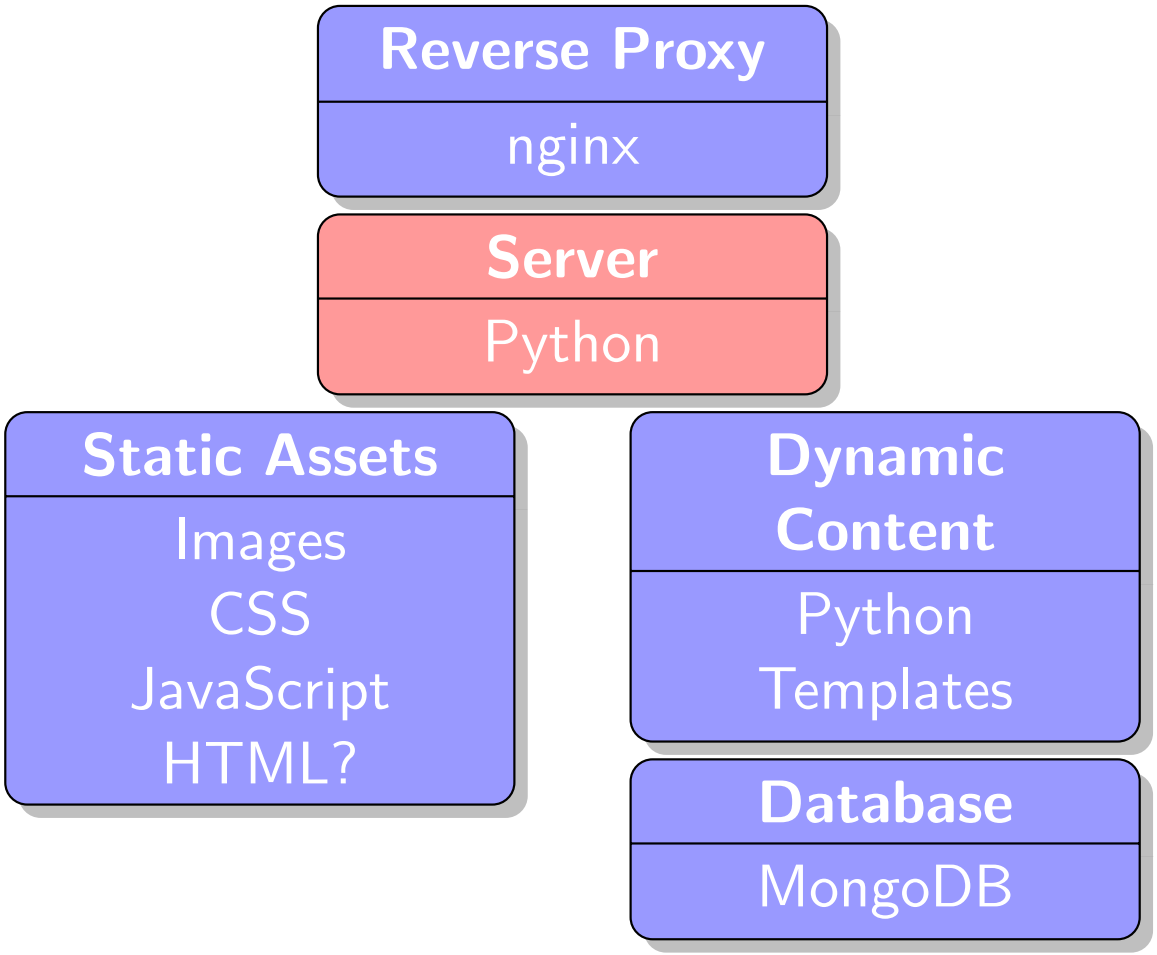
...

@route('/static/<path:path>')
def static(path):
    return static_file(path, root=static_root)
```

Best practices: commit your changes!

```
git add webapp.py
git commit -m"Serve static files out of static/"
git push
```

Server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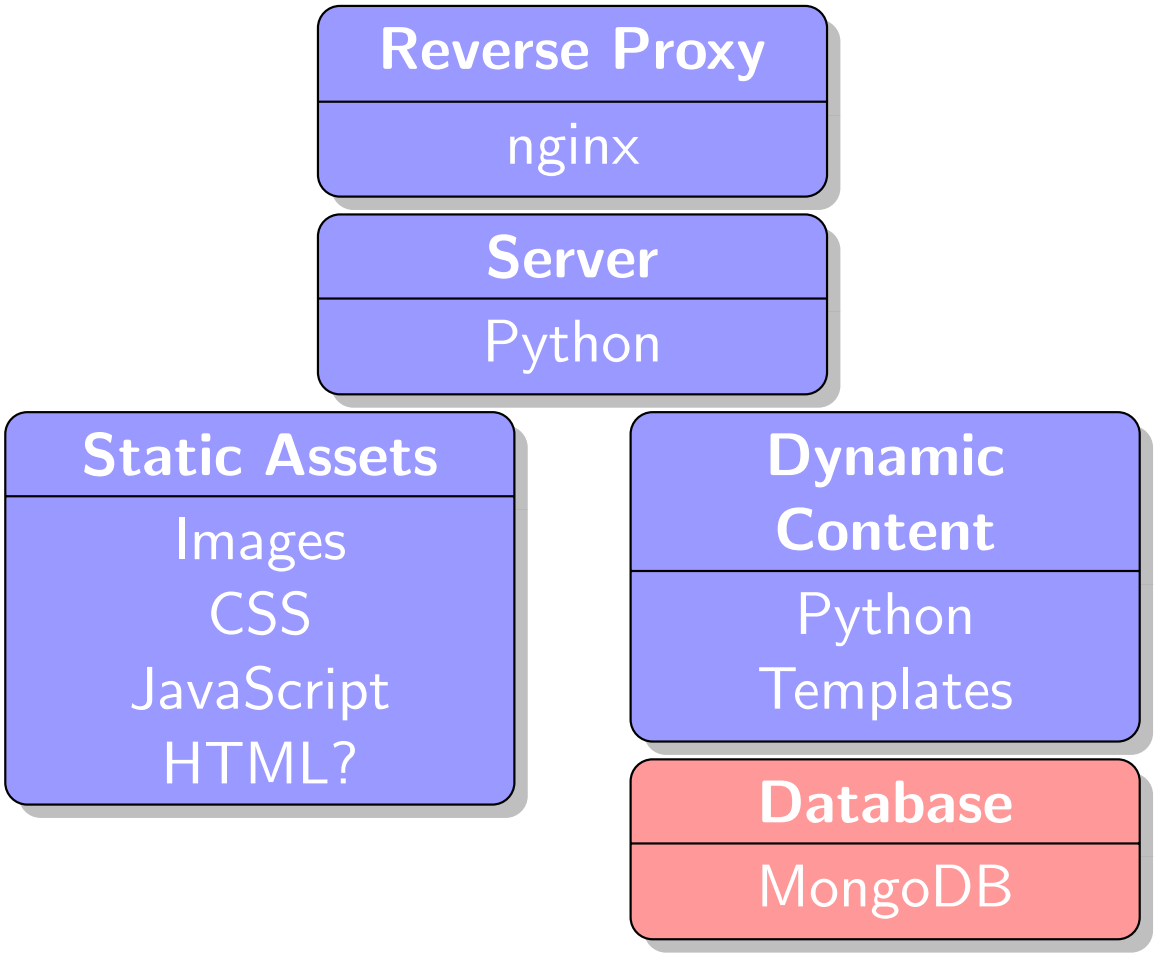
MongoDB

Database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Introducing MongoDB

Figure : MongoDB (from "humongous") is an open-source document database, and the leading NoSQL database.

NoSQL? Wat? — A diversion on databases

- Traditional database (e.g. MySQL ($\rightarrow$ MariaDB), PostgresSQL, MS-SQL) = Relational Databases
- "NoSQL" $\rightarrow$ umbrella term for a large number of non-relational databases.
  - Document: e.g. MongoDB/CouchDB
  - Key-value store: e.g. Redis
  - Other exciting things: e.g. Neo4j - graph database,

Both are *tools for different purposes*, with *different strenghts and weaknesses*. **Just because MongoDB is cool, doesn't mean it is the solution to all your problems.**

Why MongoDB for us now?

- Even with advanced database migration tools like South (for Django), it's still easier to do schema migrations in MongoDB. This helps with the sort of rapid prototyping we're doing here.
- It's really easy to store files/images in a MongoDB. Not necessarily super-efficient, but again good for prototyping.
- Often easier to wrap your head around.

Getting started with MongoDB

- Key component is a document.
- Document has a unique ID.
- Documents are JSON-like.
- Can contain arbitrary key-value pairs. Values can include arrays and other key-value mappings ('objects')

An Example

```
{ "title" : "Post",
  "content" : "I think W, Y, and Z.",
  "author" : "Daniel Axtens",
  "date" : ISODate("2013-10-25T08:45:00Z"),
  "comments" : [{
    "author" : "Anonymous",
    "content" : "First P0000st!",
    "date" : ISODate("2013-09-25T10:01:44.405Z")
  }, {
    "author" : "Mr. Helpful",
    "content" : "I think you might have missed X, \
                 which is listed on my blog.",
    "link" : "http://helpful.blog.com/",
    "date" : ISODate("2013-09-25T10:01:44.405Z")
  }]}
```

Converting this to code

Only chumps and people who enjoy getting owned write their own queries. We use MongoEngine. This is `blog_example.py`:

```
from mongoengine import *
import datetime

# Define the data-structure
class BlogPost(Document):
    title = StringField(required=True)
    content = StringField(required=True)
    author = StringField(required=True)
    date = DateTimeField(required=True, \
                         default=datetime.datetime.now)
    categories = ListField(StringField(max_length=30))
```

Now, let's connect to the database, create and save a post. (This is more of `blog_example.py`)

```
# Connect to the database
connect('blog_example')

# Save a post
post = BlogPost()
post.title = "Post"
post.content = "I think W, Y, and Z."
post.author = "Daniel Axtens"
post.save()
```

Exploring your newly created document

```
$ mongo
> use blog_example
> show collections
> db.blog_posts.find()
> db.blog_posts.find({'author': 'Daniel Axtens'})[0]
```

SQL equivalent:

```
SELECT * FROM blog_posts WHERE author = 'Daniel Axtens'
```

Retriving with MongoEngine

```
# Retrieve a post
posts = BlogPost.objects() # everything
posts = BlogPost.objects(author='Daniel Axtens') # only me
post = posts.first()
print('"%s", by "%s": %s' % \
      (post.title, post.author, post.content))

# Update it
post.title = "Freshly Updated Post"
post.save()

# Verify update
print(BlogPost.objects().first().title)
```

But I want my blog to have comments!

```
class Comment(EmbeddedDocument):
    author = StringField(required=True,
                         default="Anonymous")
    link = URLField()
    content = StringField(required=True)
    date = DateTimeField(required=True,
                         default=datetime.datetime.now)

class BlogPost(Document):
    ...
    comments = ListField(EmbeddedDocumentField(Comment))
```

But I want my blog to have comments!

```
# Add the comments
comment = Comment()
comment.content = "First P0000st!"
post.comments.append(comment)
post.save()

comment = Comment()
comment.author = "Mr. Helpful"
comment.content = "I think you've forgotten X..."
comment.link = "http://helpful.blog.com"
post.comments.append(comment)
post.save()
```

But I want my blog to have comments!

```
# Retrieve a post
posts = BlogPost.objects()
post = posts.first()
print('"%s", by "%s": %s' % \
      (post.title, post.author, post.content))
for comment in post.comments:
    if comment.link is not None:
        print('Comment by %s (%s): %s' % \
              (comment.author, comment.link, \
                   comment.content))
    else:
        print('Comment by %s: %s' % \
              (comment.author, comment.content))
```

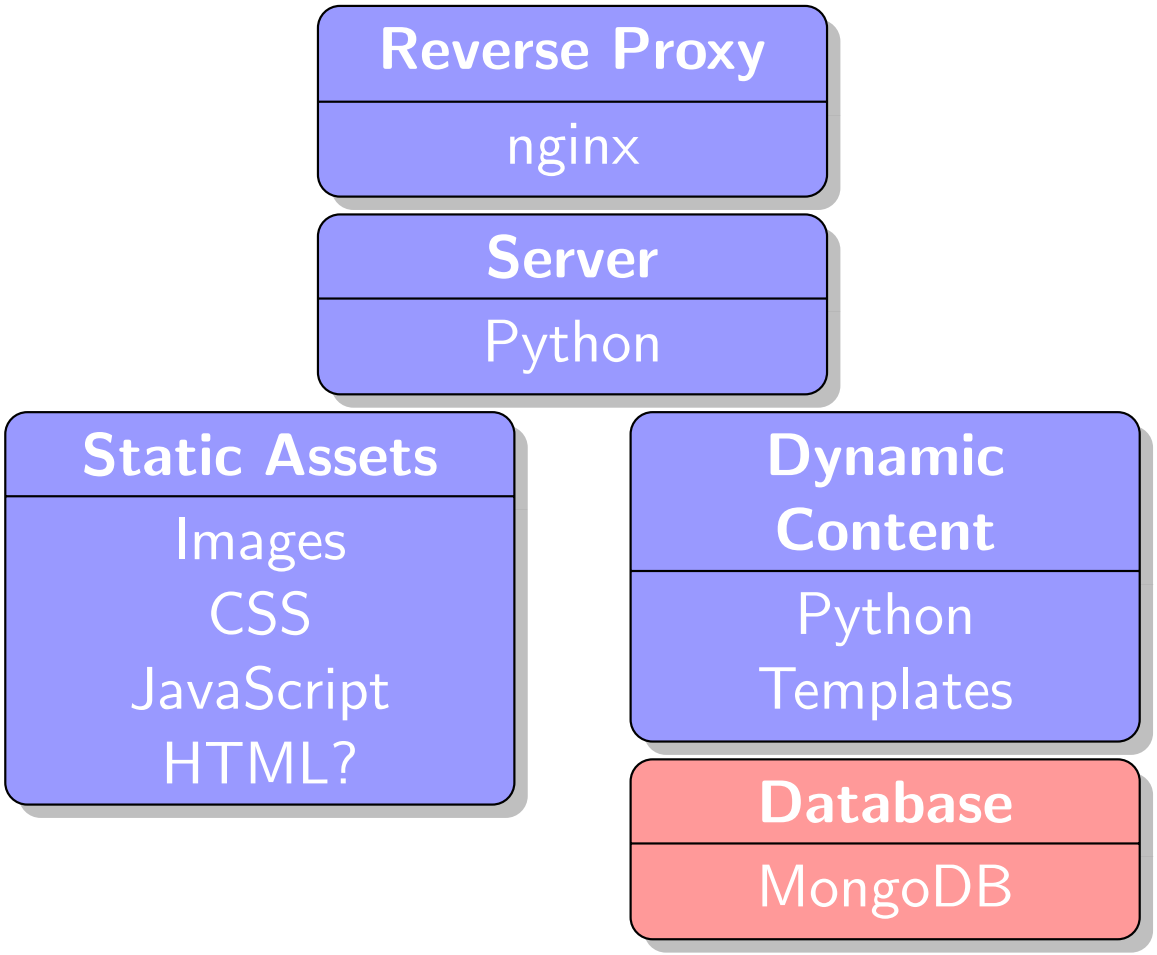
But I want my blog to have comments!

- Did you notice the seamless and painless schema migration?
- Did you notice the really, really painless Object-Document Mapping? Treating a list of comments as a Python list?

Over to you...

- What can a MongoEngine Document contain? (Highlights - see the online documentation for the full list)
  - BooleanField
  - DateTimeField
  - IntField / LongField / DecimalField / FloatField
  - DictField / MapField
  - EmailField / URLField
  - EmbeddedDocumentField
  - FileField / ImageField
  - GeoPointField
  - ListField / SortedListField
  - ReferenceField
  - StringField
- There's also an awesome inheritance system.

Database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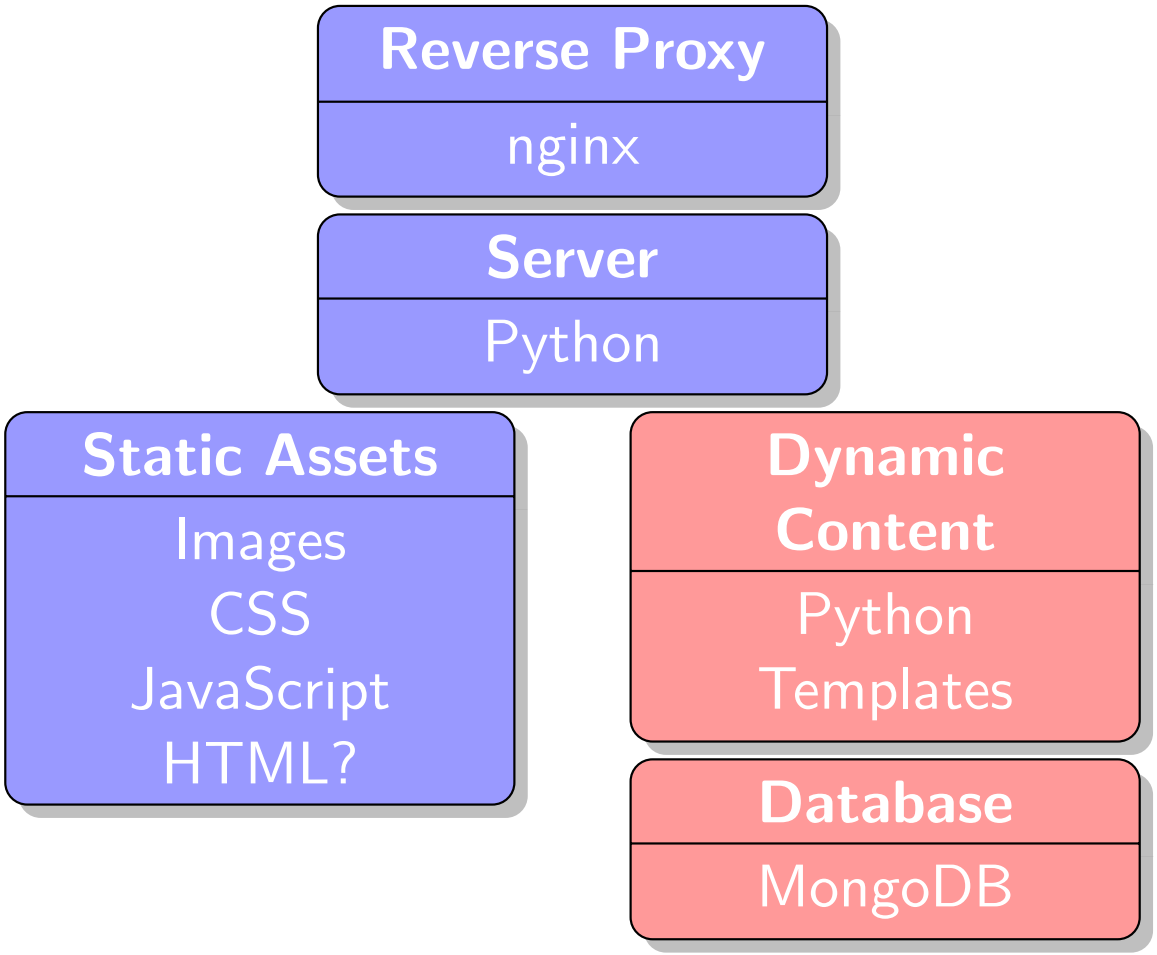
Serving up your database



Reading/Writing from your MongoDB

- I usually put all my class definitions and my `connect(...)` call in a separate file (e.g. `database.py`), then say:

  ```
  from database import *
  ```

  Although there's really no reason you couldn't have it all in one file. (Neatness concerns aside.)

Simple and stupid example

```
connect('greeter')

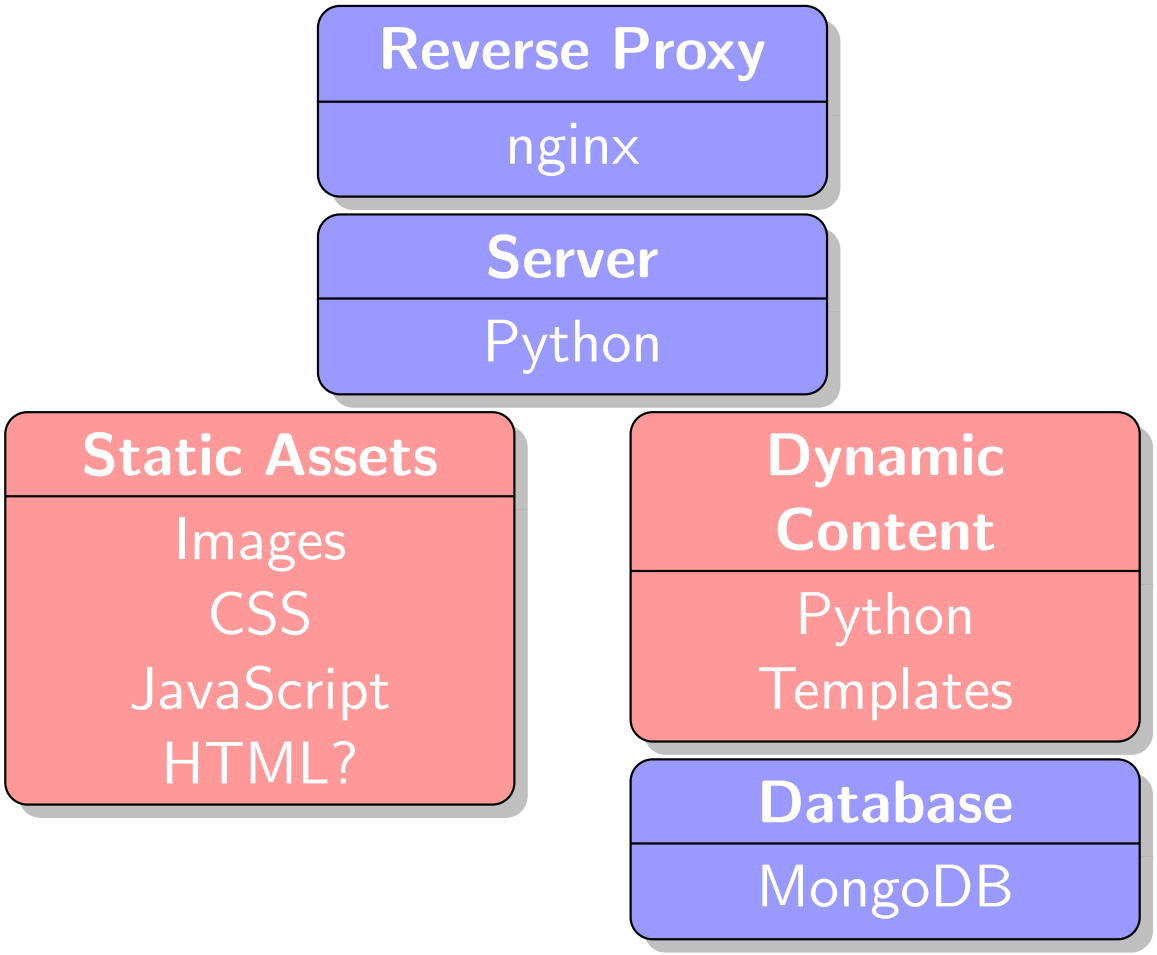
class Name(Document):
        name=StringField(default="World")

@route('/')
@route('/greet/<name>')
@view('hello')
def greet(name=None):
        # todo: not everyone should be able to set.
        dbname = Name.objects().first() or Name()
        if name is not None:
                dbname.name = name
                dbname.save()
        return {'name': dbname.name}
```

Off you go!

Now work on the core of your own app! I'll be around if you have questions or need help.

Front end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Introducing Bootstrap

Figure : Bootstrap: `getbootstrap.com`

- We're lazy, so we use Bootstrap for the frontend.

What can I do with Bootstrap?

- Have things look not-terrible with minimal effort.
- Have mobile-compatible ("responsive") layouts basically for free.
- Get a bunch of integrated client-side behaviours through jQuery.
- There are more things. (I cannot do design to save my life.)

Setting up Bootstrap

- Download it from `getbootstrap.com/getting-started`, extract the archive, put the folders in `static/`
  - *Don't download the version from the front page. Get the one with the pre-compiled JS and CSS assets.*
- Choose the example from `http://getbootstrap.com/getting-started/#examples` that best suits your project.
  - (Optionally) find it on GitHub.
  - Copy the code to `views/index.tpl`
  - Download any extra stylesheets, etc.
  - Adjust relevant links to read `/static/{js, css, etc}/...` (look for `src=`, `href=`)
  - Fill out the relevant title, meta, etc tags.
- Adjust your code to use the `index` template. Include your parameters (e.g. `{{name}}`) in there somewhere :)

But my submission page/other page/etc is still ugly!

- You could copy-paste the template code. Or you could save yourself huge amounts of effort by being smart.
- Create `bootstrapbase.tpl`, and copy-paste the content of `index.tpl`.
- Delete everything from (and including):
  `<div class="jumbotron">`
  to (and not including):
  `<div class="footer">`
  Replacing it with the text `%include`.
- Title (replace Slogan Generator with your project name):

```
<title>{{get('title', 'Slogan Generator')}}</title>
```

- Likewise with meta tags, you can pass them in as a variable if needed.

But my submission page/other page/etc is still ugly!

- Now back to `index.tpl`.
- Delete everything *except* what we deleted from `bootstrapbase.tpl`
- At the top of `index.tpl` add:
  `%rebase bootstrapbase`

Contacts page

webapp.py:

```
@route('/contact')
@view('contact')
def contact():
        return {}
```

views/contact.tpl:

```
%rebase bootstrapbase title='Contact'
<p>I have no idea why on earth you'd want to contact me
      over this.<p>
<p>You could <a href="mailto:daniel@axtens.net">email me</a
      I guess?</p>
```

- This doesn't deal correctly with the highlighting in the top bar. This is a bit fiddly so I'm not going to go through it now. Some sample code is included, however.
- As things start to get more complicated (replacing chunks of different pages), it's time to swap out SimpleTemplate for a less simple system (e.g. Jinja). (It's possibly also time to move to a more comprehensive framework.)

Buzzword time: AJAX

- AJAX stands for Asynchronous JavaScript and XML.
- That's not how the term is used any more, however.
  - JSON (JavaScript Object Notation) >> XML (eXtensible Markup Language)
  - It can also be synchronous.
  - Umbrella term for "getting stuff from a server without loading an entire page again".
- jQuery (which comes for free with Bootstrap) makes AJAX painless. ... or at least as painless as something in JavaScript can be.

AJAX: JSON

- JSON is awesome. We've seen it before with MongoDB. It is also the way JavaScript expresses objects.
- Key-value, {...} for objects, [...] for arrays.
- Trivial to parse and generate in every useful language! (Don't DIY it, and especially don't use JS's eval function on it.)
- Lets make our server spit out JSON!

Back to webapp.py

- `from bottle import route, run, ..., response`
- `import json`
- ```
  @route('/slogan.json')
  def sloganjson():
          response.set_header('Content-Type',
                              'application/json')
          return json.dumps(randomslogan())
  ```
  ```

Front end: Introducing jQuery

Figure : jQuery — write less, do more. `http://jquery.com`

- jQuery makes JavaScript in the browser not suck.
- I heart it immensely.

Front end—`index.tpl`

- (These will probably be different for you. I'll run through it and then be around to help.)
- Add `id="slogan"` to the `h1` with {{`slogan`}}.
- Add `id="generate"` to the `a` with `role="button"`. If you've changed the `href`, change it back to `#`.

Front end—static/js/ajax.js

```
function generateButton() {
    // get the JSON. TODO: handle errors
    $.getJSON('/slogan.json', function(data) {
        // callback when the data is returned
        // we set the slogan
        $(slogan).text(data.slogan);
    });
}

// when the document is loaded:
$(document).ready(function(){
    // wire up the generate button
    $('#generate').on('click', generateButton);
});
```

Including the script—a bit of hackery in `bootstrapbase.tpl`

After the other scripts:

```
<script src="/static/js/ajax.js"></script>
```

Yes, this isn't particularly extensible. But jQuery falls over nicely.

Hurray, AJAX!

Don't forget to save to git!

A review: what have we done?

- A web server written in Python...
- ... reading and writing data from MongoDB ...
- ... with a front end made less ugly by Bootstrap ...
- ... with interactivity through AJAX, implemented in jQuery...
- ... running in a virtual machine on your computer.

Deploying your app!

- As exciting as virtual machines on your computer are...
- ... virtual machines on someone else's computer are cooler ...
- ... especially when that other computer is permanently connected to the internet.

One small thing...

Take out `debug=True, reloader=True` from `webapp.py`.

Re-introducing AWS

Figure : Amazon Web Services delivers a set of services that together form a reliable, scalable, and inexpensive computing platform "in the cloud". `aws.amazon.com`

Somewhere to put your code

```
sudo adduser --disabled-password webapp
```

Getting your source code to the server: introducing Fabric

Fabric is a Python (2.5 or higher) library and command-line tool for streamlining the use of SSH for application deployment or systems administration tasks.

`http://fabfile.org`

fabfile.py

```
from fabric.api import *

def setup():
    sudo("pip install bottle mongoengine bottle-cork")

def deploy():
    # create tarball
    local("tar -czf webapp.tgz webapp.py database.py" +
          " views static")
    # upload and extract
    put("webapp.tgz", "/tmp/webapp.tgz")
    with cd("/home/webapp"):
        sudo("tar -xzf /tmp/webapp.tgz")
    # clean up
    run("rm /tmp/webapp.tgz")
```

Let's go!

- `sudo apt-get -y install python-pip python-dev mongodb`
- `fab -u ubuntu -H` *`number`*`.compcon.dja.id.au setup`
- `fab -u ubuntu -H` *`number`*`.compcon.dja.id.au deploy`
- `sudo -u webapp -s`
  `python webapp.py`
- Your code should be running, but the website won't work on port 80, and 8080 is firewalled off.

What not to do

- "Why don't we just set `port=80` in the `run` function call?"

What not to do

- "Why don't we just set `port=80` in the `run` function call?"
- "Oh, that's odd, it can't bind to port 80. Oh, it's a privileged port? Oh, I can just run it as root!"

What not to do

- "Why don't we just set `port=80` in the `run` function call?"
- "Oh, that's odd, it can't bind to port 80. Oh, it's a privileged port? Oh, I can just run it as root!"
- "Yay, it works now!"

What not to do

- "Why don't we just set `port=80` in the `run` function call?"
- "Oh, that's odd, it can't bind to port 80. Oh, it's a privileged port? Oh, I can just run it as root!"
- "Yay, it works now!"
- <ring ring> "Hello, this is developer" ... "What do you mean my app got owned? My server got owned? And wiped out everything else on the server?"

What not to do

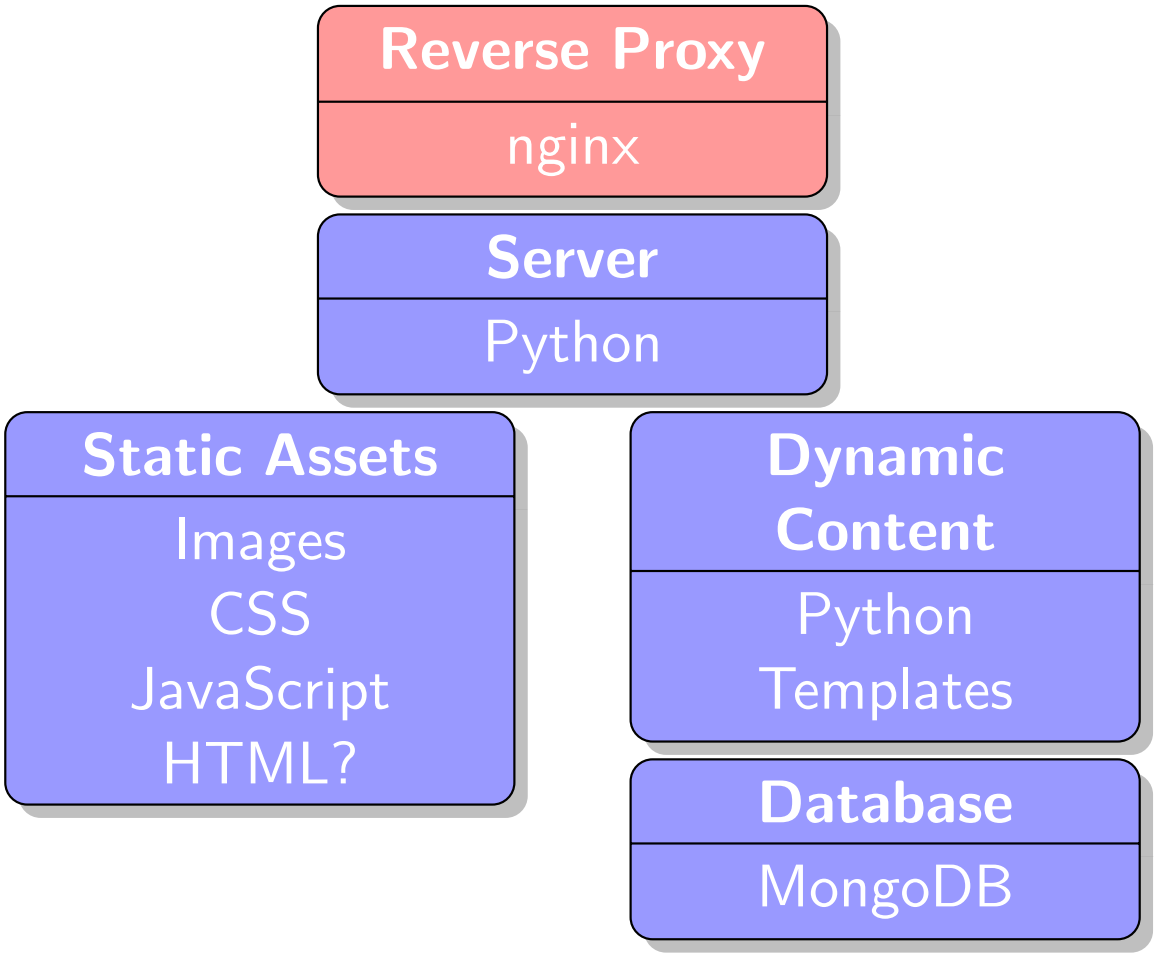
Don't run your app as root. Ever. Not even for a little while.

Introducing our saviour ... nginx

Figure : nginx

- `sudo apt-get -y install nginx-light`

Reverse Proxy



sudo nano /etc/nginx/sites-available/default

```
server {
        server_name NUMBER.compcon.dja.id.au;

        location / {
                proxy_pass http://localhost:8080/;
        }
}
```

- sudo service nginx restart
- Start your process and (assuming it doesn't rely on a pre-seeded database!) it should work!

"Staying alive, staying alive"
Introducing `supervisord`

Figure : Supervisord: hang on to your processes.
`http://supervisord.org`

- `sudo apt-get -y install supervisor`

sudo nano /etc/supervisord/conf.d/webapp.conf

```
[program:webapp]
user=webapp
command=python /home/webapp/webapp.py
autostart=true
autorestart=true
```

```
sudo service supervisor stop; sudo service supervisor
start;
```

Oh no, it's b0rked!

- `webapp.py`:

```
if root:
    os.chdir(root)
```

Oh no, it's b0rked!

- webapp.py:

```
if root:
    os.chdir(root)
```

- `fab -u ubuntu -H number.compcon.dja.id.au deploy`
- `sudo supervisorctl restart webapp`

Oh no, it's b0rked!

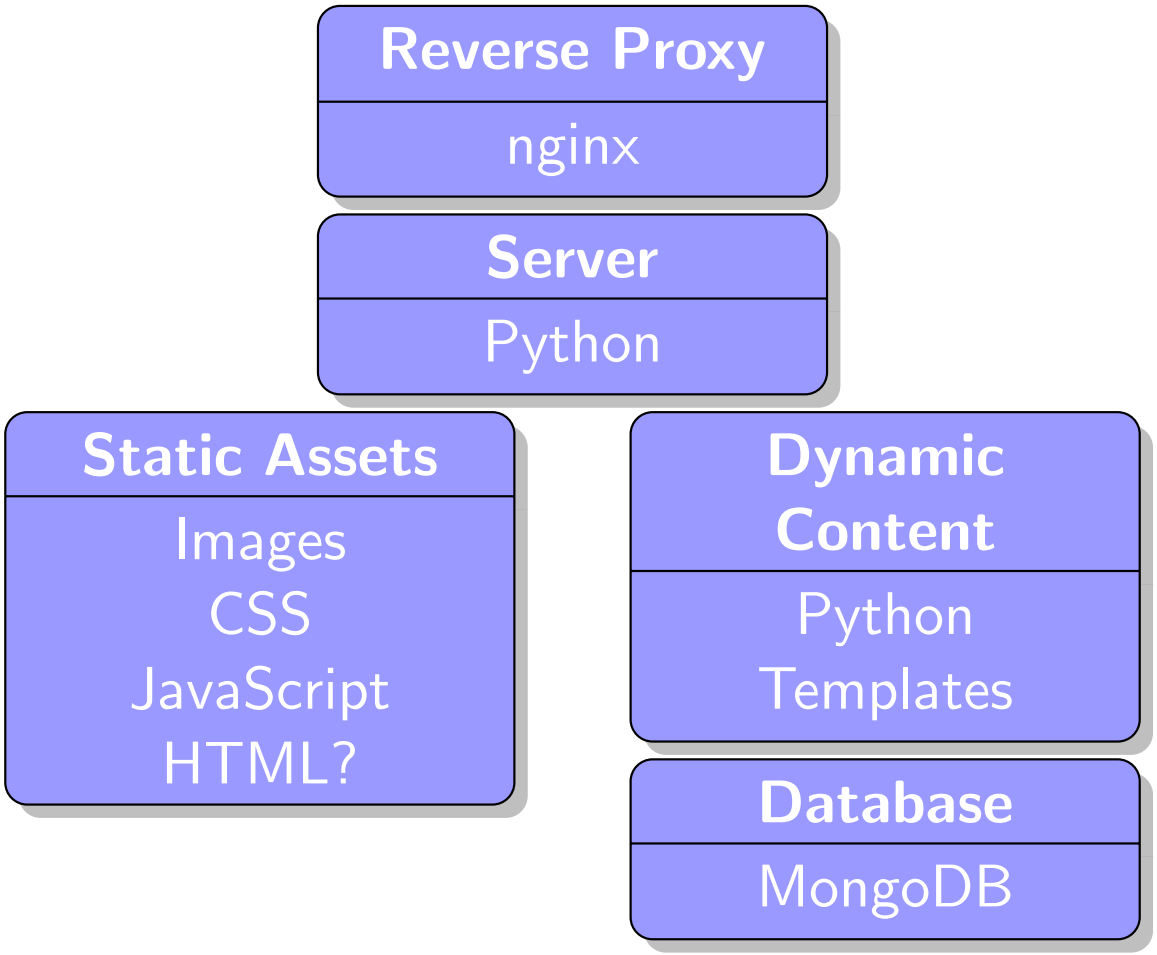
- `webapp.py`:

```
if root:
    os.chdir(root)
```

- `fab -u ubuntu -H number.compcon.dja.id.au deploy`
- `sudo supervisorctl restart webapp`
- (even better, add the following to `fabfile.py`)

```
sudo("supervisorctl restart webapp")
```

Recap


Reverse Proxy
nginx
Server
Python
Static Assets
Images
CSS
JavaScript
HTML?
Dynamic Content
Python
Templates
Database
MongoDB

Further directions

- If you're still sorting out bugs, etc., keep working on that.
- If not, here's some stuff we can look at adding:
  - Google Analytics
  - Authentication
  - Speed improvements
  - CloudFlare

Introducing Google Analytics

Figure : Google Analytics: Turning data insights into action.
`http://google.com/analytics`

You can figure this out yourself. Just copy the snippet into `bootstrapbase.tpl`.

Authentication

- We probably don't have time to cover this properly.

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- (Daniel rants about security.)

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- Introducing Cork.

Authentication

- We probably don't have time to cover this properly.
- (Daniel rants about security.)
- Introducing Cork.
- Seriously consider a more heavy-weight framework.

"You are not done yet"

- Your site is slow. `nginx` can make it faster with gzipping, caching and by retrieving assets without going through Bottle.
- Bottle is slow because it uses a reference WSGI server. Try CherryPy or Paste.
- Consider CloudFlare.
- Consider accessibility.

Bonus: "With great power comes great responsibility" Introducing Boto

- "I have a workshop coming up where I want 30 people to have virtual machines with custom DNS names. Setting up each one takes a couple of minutes and I am very, very lazy."