
Effective Django

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Django is a popular, powerful web framework for Python. It has lots of “batteries” included, and makes it easy to get up and going. But all of the power means you can write low quality code that still seems to work. So what does *Effective Django* mean? It means using Django in a way that emphasizes writing code that’s cohesive, testable, and scalable. What do each of those words mean? Well, “cohesive” code is code that is focused on doing one thing, and one thing alone. It means that when you write a function or a method, that it does one thing and does it well.

This is directly related to writing testable code: code that’s doing too much is often difficult to write tests for. When I find myself thinking, “Well, this piece of code is just too complex to write a test for, it’s not really worth all the effort,” that’s a signal that I need to step back and focus on simplifying it. Testable code is code that makes it straight-forward to write tests for, and that’s easy to diagnose problems with.

Finally, we want to write scalable code. That doesn’t just mean it scales in terms of performance, but that it also scales in terms of your team and your team’s understanding. Applications that are well tested are easier for others to understand (and easier for them to modify), which means you’re more able to improve your application by adding engineers.

My goal is to convince you of the importance of these principles, and provide examples of how to follow them to build more robust Django applications. I’m going to walk through building a contact management application iteratively, talking about the choices and testing strategy as I go.

The sample code for this tutorial is available in the [effective-django-tutorial](https://github.com/nyergler/effective-django-tutorial/) (<https://github.com/nyergler/effective-django-tutorial/>) git repository.

Slides for the tutorial are available at <http://effectivedjango.com/slides/tutorial>

GETTING STARTED

1.1 Your Development Environment

When thinking about your development environment, there are three important things to keep in mind: isolation, determinism, and similarity. They're each important, and they work in concert with one another.

Isolation means that you're not inadvertently leveraging tools or packages installed outside the environment. This is particularly important when it comes to something like Python packages with C extensions: if you're using something installed at the system level and don't know it, you can find that when you go to deploy or share your code that it doesn't operate the way you expect. A tool like [virtualenv](http://www.virtualenv.org/) (<http://www.virtualenv.org/>) can help create that sort of environment.

Your environment is **deterministic** if you're confident about what versions of your dependencies you're relying on, and can reproduce that environment reliably.

Finally, **similarity** to your production or deployment environment means you're running on the same OS, preferably the same release, and that you're using the same tools to configure your development environment that you use to configure your deployment environment. This is by no means a requirement, but as you build bigger, more complex software, it becomes advantageous to remove another variable from thing.

1.1.1 Isolation

- We want to avoid using unknown dependencies, or unknown versions
- [virtualenv](http://www.virtualenv.org/) (<http://www.virtualenv.org/>) provides an easy way to work on a project without your system's `site-packages`

1.1.2 Determinism

- Determinism is all about dependency management
- Choose a tool, use it in development and production
 - `pip`, specifically a [requirements files](http://www.pip-installer.org/en/latest/requirements.html) (<http://www.pip-installer.org/en/latest/requirements.html>)
 - [buildout](http://www.buildout.org/) (<http://www.buildout.org/>)
 - [install_requires](http://pythonhosted.org/distribute/setuptools.html#declaring-dependencies) (<http://pythonhosted.org/distribute/setuptools.html#declaring-dependencies>) in `setup.py`
- Identify specific versions of dependencies

You can specify versions either by the version for a package on PyPI, or a specific revision (SHA in git, revision number in Subversion, etc). This ensures that you're getting the exact version you're testing with.

1.1.3 Similarity

- Working in an environment similar to where you deploy eliminates variables when trying to diagnose an issue
- If you're building something that requires additional services, this becomes even more important.
- **Vagrant** (<http://vagrantup.com/>) is a tool for managing virtual machines, let's you easily create an environment separate from your day to day work.

1.2 Setting Up Your Environment

1.2.1 Create a Clean Workspace

```
$ mkdir tutorial
$ virtualenv ./tutorial/
New python executable in ./tutorial/bin/python
Installing setuptools.....done.
Installing pip.....done.
$ source ./tutorial/bin/activate
(tutorial)$
```

1.2.2 Start a Requirements File

Create a `requirements.txt` in the `tutorial` directory with a single requirement in it.

```
Django==1.4.3
```

1.2.3 Installing Requirements

And then we can use **pip** (<http://www.pip-installer.org/>) to install the dependencies.

```
(tutorial)$ pip install -U -r requirements.txt

Downloading/unpacking Django==1.4.3 (from -r requirements.txt (line 1))
  Downloading Django-1.4.3.tar.gz (7.7Mb): 7.7Mb downloaded
  Running setup.py egg_info for package Django

Installing collected packages: Django
  Running setup.py install for Django
    changing mode of build/scripts-2.7/django-admin.py from 664 to 775

    changing mode of /home/nathan/p/contacts/bin/django-admin.py to 775
Successfully installed Django
Cleaning up...
```

1.3 Beginning a Django Project

1.3.1 Scaffolding

- Django provides file system scaffolding just like HTTP scaffolding

- Helps engineers understand where to find things when they go looking
- Django 1.4 made a change that decouples apps from projects
- In Django parlance, your **project** is a collections of **applications**.

1.3.2 Creating the Project

Django installs a `django-admin.py` script for handling scaffolding tasks. We'll use `startproject` to create the project files. We specify the project name and the directory to start in; we're already in our isolated environment so we can just say `.`

```
(tutorial)$ django-admin.py startproject addressbook .
```

```
manage.py
./addressbook
    __init__.py
    settings.py
    urls.py
    wsgi.py
```

1.3.3 Project Scaffolding

- `manage.py` is a pointer back to `django-admin.py` with an environment variable set, pointing to your project as the one to read settings from and operate on when needed.
- `settings.py` is where you'll configure your project. It has a few sensible defaults, but no database chosen when you start.
- `urls.py` contains the URL to view mappings: we'll talk more about that shortly.
- `wsgi.py` is a [WSGI](https://en.wikipedia.org/wiki/Web_Server_Gateway_Interface) (https://en.wikipedia.org/wiki/Web_Server_Gateway_Interface) wrapper for your application. This is used by Django's development servers, and possibly other containers like `mod_wsgi`, `uwsgi`, etc. in production.

1.3.4 Creating the “App”

```
(tutorial)$ python ./manage.py startapp contacts
```

```
./addressbook
./contacts
    __init__.py
    models.py
    tests.py
    views.py
```

- Beginning in Django 1.4, *apps* are placed alongside *project* packages. This is a great improvement when it comes to deployment.
- `models.py` will contain the Django ORM models for your app.
- `views.py` will contain the View code
- `tests.py` will contain the unit and integration tests you write.

1.4 Review

- Make sure your development environment is deterministic and as similar to where you'll deploy as possible
- Specify explicit versions for your dependencies
- Django organizes code into “Projects” and “Applications”
- Applications are [potentially] reusable

USING MODELS

2.1 Configuring the Database

Django includes support out of the box for MySQL, PostgreSQL, SQLite3, and Oracle. [SQLite3](http://docs.python.org/2/library/sqlite3.html) (<http://docs.python.org/2/library/sqlite3.html>) is included with Python starting with version 2.5, so we'll use it for our project for simplicity. If you were going to use MySQL, for example, you'd need to add [mysql-python](https://pypi.python.org/pypi/MySQL-python) (<https://pypi.python.org/pypi/MySQL-python>) to your `requirements.txt` file.

To enable SQLite as the database, edit the `DATABASES` definition in `addressbook/settings.py`. The `settings.py` file contains the Django configuration for our project. There are some settings that you must specify – like the `DATABASES` configuration – and others that are optional. Django fills in some defaults when it generates the project scaffolding, and the documentation contains a [full list of settings](https://docs.djangoproject.com/en/1.5/ref/settings/) (<https://docs.djangoproject.com/en/1.5/ref/settings/>). You can also add your own settings here, if needed.

For SQLite we need to set the engine and then give it a name. The SQLite backend uses the `NAME` as the filename for the database.

```
DATABASES = {
    'default': {
        'ENGINE': 'django.db.backends.sqlite3', # 'postgresql_psycopg2', 'mysql', 'sqlite3' or 'oracle'
        'NAME': 'address.db',
        'USER': '',                               # Not used with sqlite3.
        'PASSWORD': '',                           # Not used with sqlite3.
        'HOST': '',                               # Set to empty string for localhost. Not used with sqlite3.
        'PORT': '',                               # Set to empty string for default. Not used with sqlite3.
    }
}
```

Note that the database engine is specified as a string, and not a direct reference to the Python object. This is because the settings file needs to be easily importable, without triggering any side effects. You should avoid adding imports to the settings file.

You rarely need to import the settings file directly; Django imports it for you, and makes it available as `django.conf.settings`. You typically import your settings from `django.conf`:

```
from django.conf import settings
```

2.2 Creating a Model

Django models map (roughly) to a database table, and provide a place to encapsulate business logic. All models subclass the base [Model](https://docs.djangoproject.com/en/1.5/ref/models/instances/#django.db.models.Model) (<https://docs.djangoproject.com/en/1.5/ref/models/instances/#django.db.models.Model>)

class, and contain field definitions. Let's start by creating a simple Contact model for our application in `contacts/models.py`.

```
from django.db import models

class Contact(models.Model):

    first_name = models.CharField(
        max_length=255,
    )
    last_name = models.CharField(
        max_length=255,
    )

    email = models.EmailField()

    def __str__(self):

        return ' '.join([
            self.first_name,
            self.last_name,
        ])
```

Django provides a set of [fields](https://docs.djangoproject.com/en/1.5/ref/models/fields/) (<https://docs.djangoproject.com/en/1.5/ref/models/fields/>) that map to data types and different validation rules. For example, the `EmailField` here maps to the same column type as the `CharField`, but adds validation for the data.

Once you've created a model, you need to update your database with the new tables. Django's `syncdb` command looks for models that are installed and creates tables for them if needed.

```
(tutorial)$ python ./manage.py syncdb

Creating tables ...
Creating table auth_permission
Creating table auth_group_permissions
Creating table auth_group
Creating table auth_user_user_permissions
Creating table auth_user_groups
Creating table auth_user
Creating table django_content_type
Creating table django_session
Creating table django_site

...
```

Our contact table isn't anywhere to be seen. The reason is that we need to tell the Project to use the Application.

The `INSTALLED_APPS` setting lists the applications that the project uses. These are listed as strings that map to Python packages. Django will import each and looks for a `models` module there. Add our Contacts app to the project's `INSTALLED_APPS` setting:

```
INSTALLED_APPS = (
    'django.contrib.auth',
    'django.contrib.contenttypes',
    'django.contrib.sessions',
    'django.contrib.sites',
    'django.contrib.messages',
    'django.contrib.staticfiles',
```

```

# Uncomment the next line to enable the admin:
# 'django.contrib.admin',
# Uncomment the next line to enable admin documentation:
# 'django.contrib.admindocs',
'contacts',
)

```

Then run syncdb again:

```

(tutorial)$ python ./manage.py syncdb
Creating tables ...
Creating table contacts_contact
Installing custom SQL ...
Installing indexes ...
Installed 0 object(s) from 0 fixture(s)

```

Note that Django created a table named `contacts_contact`: by default Django will name your tables using a combination of the application name and model name. You can override that with the `model Meta` (<https://docs.djangoproject.com/en/1.5/ref/models/options/>) options.

2.3 Interacting with the Model

Now that the model has been synced to the database we can interact with it using the interactive shell.

```

(tutorial)$ python ./manage.py shell
Python 2.7.3 (default, Aug 9 2012, 17:23:57)
[GCC 4.7.1 20120720 (Red Hat 4.7.1-5)] on linux2
Type "help", "copyright", "credits" or "license" for more information.
(InteractiveConsole)
>>> from contacts.models import Contact
>>> Contact.objects.all()
[]
>>> Contact.objects.create(first_name='Nathan', last_name='Yergler')
<Contact: Nathan Yergler>
>>> Contact.objects.all()
[<Contact: Nathan Yergler>]
>>> nathan = Contact.objects.get(first_name='Nathan')
>>> nathan
<Contact: Nathan Yergler>
>>> print nathan
Nathan Yergler
>>> nathan.id
1

```

There are a few new things here. First, the `manage.py shell` command gives us a interactive shell with the Python path set up correctly for Django. If you try to run Python and just import your application, an Exception will be raised because Django doesn't know which settings to use, and therefore can't map Model instances to the database.

Second, there's this `objects` property on our model class. That's the model's `Manager` (<https://docs.djangoproject.com/en/1.5/topics/db/managers/>). If a single instance of a Model is analogous to a row in the database, the Manager is analogous to the table. The default model manager provides querying functionality, and can be customized. When we call `all()` or `filter()` or the Manager, a `QuerySet` is returned. A `QuerySet` is iterable, and loads data from the database as needed.

Finally, there's this `id` field that we didn't define. Django adds an `id` field as the primary key for your model, unless you specify a primary key (<https://docs.djangoproject.com/en/1.5/topics/db/models/#automatic-primary-key-fields>).

2.4 Writing a Test

We have one method defined on our model, `__str__`, and this is a good time to start writing tests. The `__str__` method of a model will get used in quite a few places, and it's entirely conceivable it'd be exposed to end users. It's worth writing a test so we understand how we expect it to operate.

```
class ContactTests(TestCase):
    """Contact model tests."""

    def test_str(self):

        contact = Contact(first_name='John', last_name='Smith')

        self.assertEqual(
            str(contact),
            'John Smith',
        )
```

You can run the tests for your application using `manage.py`:

```
(tutorial)$ python manage.py test
```

If you run this now, you'll see that around 420 tests run. That's surprising, since we've only written one. That's because by default Django runs the tests for all installed applications. When we added the `contacts` app to our project, there were several Django apps there by default. The extra 419 tests come from those.

If you want to run the tests for a specific app, just specify the app name on the command line:

```
(tutorial)$ python manage.py test contacts
Creating test database for alias 'default'...
..
-----
Ran 2 tests in 0.000s

OK
Destroying test database for alias 'default'...
$
```

One other interesting thing to note before moving on is the first and last line of output: “Creating test database” and “Destroying test database”. Some tests need access to a database, and because we don't want to mingle test data with “real” data (for a variety of reasons, not the least of which is determinism), Django helpfully creates a test database for us before running the tests. Essentially it creates a new database, and runs `syncdb` on it. Additionally, it resets it between each test, so that data generated or changed in one test won't break or influence another.

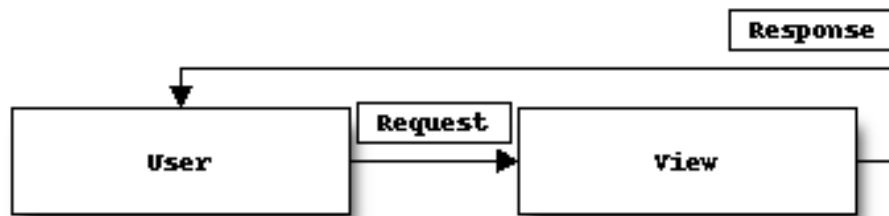
2.5 Review

- Models define the fields in a table, and can contain business logic.
- The `syncdb` manage command creates the tables in your database from models
- The model Manager allows you to operate on the collection of instances: querying, creating, etc.
- Write unit tests for methods you add to the model
- The `test` manage command runs the unit tests

WRITING VIEWS

3.1 View Basics

- Views take an HTTP Request and return a Response



- Any callable that takes a Request can be a view
- Like other frameworks, Django can pass values from the URL to the view, as well

3.2 Generic & Class Based Views

- **Generic Views** (<https://docs.djangoproject.com/en/1.5/topics/class-based-views/generic-display/>) have always provided some basic functionality: render a template, redirect, create or edit a model, etc.
- Django 1.3 introduced **Class Based Views** (<https://docs.djangoproject.com/en/1.5/topics/class-based-views/>) (CBV) for the generic views
- Provide higher levels of abstraction and composability
- Also hide a lot of complexity, which can be confusing for the newcomer
- Luckily the documentation is **much** better with Django 1.5

Django 1.3 introduced class based views, which is what we'll be focusing on here. Class based views, or CBVs, can eliminate a lot of boilerplate from your views, especially for things like an edit view where you want to take different action on a GET vs POST. They give you a lot of power to compose functionality from pieces. The downside is that this power comes with some added complexity.

3.3 Class Based Views

The minimal class based view subclasses `View` (<https://docs.djangoproject.com/en/1.5/ref/class-based-views/base/#view>) and implements methods for the HTTP methods it supports.

```
from django.http import HttpResponseRedirect
from django.view.generic import View

class MyView(View):

    def get(self, request, *args, **kwargs):
        return HttpResponseRedirect("Hello, World")
```

3.4 Listing Contacts

We'll start with a view that presents a list of contacts in the database.

The basic view implementation is shockingly brief. We can write the view in just a few lines in the `views.py` file in our `contacts` application.

```
from django.views.generic import ListView

from contacts.models import Contact

class ListContactView(ListView):
```

```
    model = Contact
```

The `ListView` (<https://docs.djangoproject.com/en/1.5/ref/class-based-views/generic-display/#listview>) that we subclass from is itself composed of several mixins that provide some behavior, and that composition gives us a lot of power without a lot of code. In this case we set `model = Contact`, which says that this view is going to list *all* the Contacts in our database.

3.5 Defining URLs

Django looks for the URL configuration in `urls.py` in your project. Let's add a URL mapping for our contact list view.

```
from django.conf.urls import patterns, include, url

import contacts.views

urlpatterns = patterns('',
    url(r'^$', contacts.views.ListContactView.as_view(),
        name='contacts-list',),
)
```

- Use of the `url()` function is not strictly required, but I like it: when you start adding more information to the URL pattern, it lets you use named parameters, making everything more clear.
- The first parameter is a regular expression. Note the trailing `$`; why might that be important?

- The second parameter is the view callable. It can either be the actual callable (imported manually), or a string describing it. If it's a string, Django will try to import the module (up to the final dot, `contacts.views` in this case), and then call the final part (`index` in this case).
- Note that when we're using a class based view, we *must* use the real object here, and not the string notation. That's because we have to call the class method `as_view()`, which returns a wrapper around our class that Django's URL dispatch can call.
- Giving a URL pattern a name allows you to do a reverse lookup
- The URL name is useful when linking from one View to another, or redirecting, as it allows you to manage your URL structure in one place

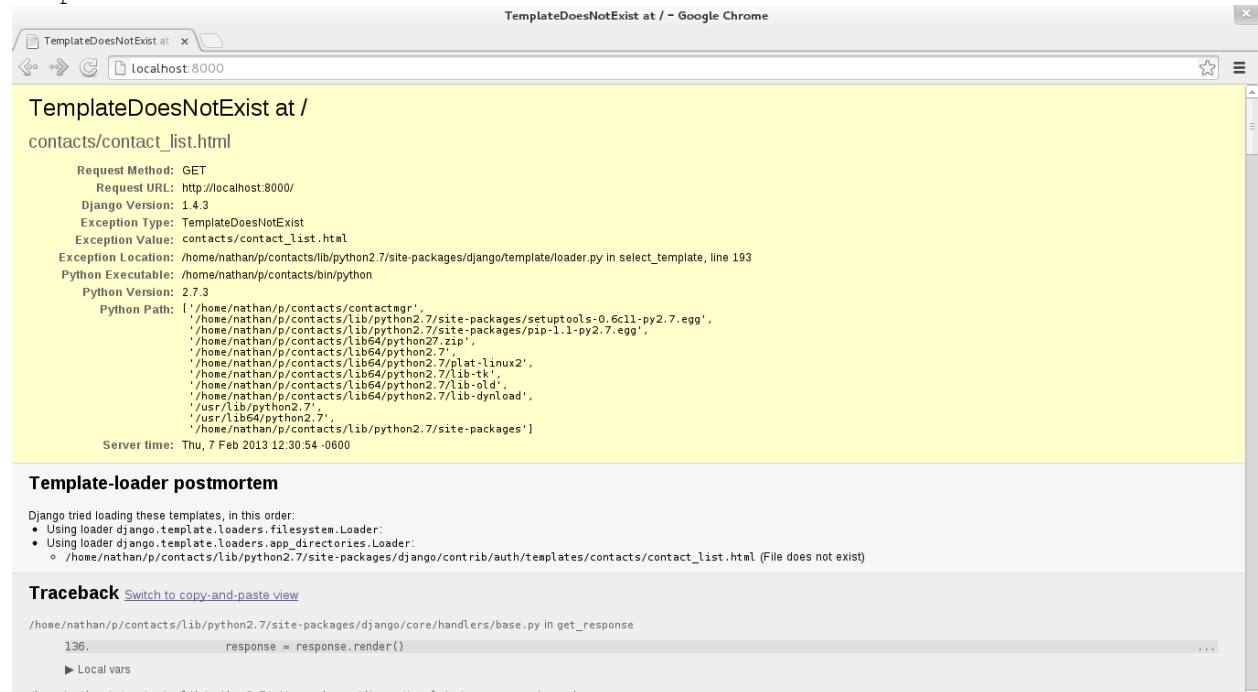
3.6 Creating the Template

Now that we've defined a URL for our list view, we can try it out. Django includes a server suitable for development purposes that you can use to easily test your project:

```
$ python manage.py runserver
Validating models...

0 errors found
Django version 1.4.3, using settings 'addressbook.settings'
Development server is running at http://127.0.0.1:8000/
Quit the server with CONTROL-C.
```

If you visit the `http://localhost:8000/` in your browser, though, you'll see an error: `TemplateDoesNotExist`.



Most of Django's generic views (such as `ListView` which we're using) have a predefined template name that they expect to find. We can see in this error message that this view was expecting to find `contact_list.html`, which is derived from the model name. Let's go and create that.

By default Django will look for templates in applications, as well as in directories you specify in `settings.TEMPLATE_DIRS`. The generic views expect that the templates will be found in a directory named after the application (in this case `contacts`), and the filename will contain the model name (in this case `contact_list.html`). This works very well when you're distributing a reusable application: the consumer can create templates that override the defaults, and they're clearly stored in a directory associated with the application.

For our purposes, however, we don't need that extra layer of directory structure, so we'll specify the template to use explicitly, using the `template_name` property. Let's add that one line to `views.py`.

```
from django.views.generic import ListView

from contacts.models import Contact

class ListContactView(ListView):

    model = Contact
    template_name = 'contact_list.html'
```

Create a templates subdirectory in our `contacts` application, and create `contact_list.html` there.

```
<h1>Contacts</h1>

<ul>
    {% for contact in object_list %}
        <li>{{ contact }}</li>
    {% endfor %}
</ul>
```

Opening the page in the browser, we should see one contact there, the one we added earlier through the interactive shell.

3.7 Creating Contacts

Adding information to the database through the interactive shell is going to get old fast, so let's create a view for adding a new contact.

Just like the list view, we'll use one of Django's generic views. In `views.py`, we can add the new view:

```
from django.core.urlresolvers import reverse
...
class CreateContactView(CreateView):

    model = Contact
    template_name = 'edit_contact.html'

    def get_success_url(self):
        return reverse('contacts-list')
```

Most generic views that do form processing have the concept of the "success URL": where to redirect the user when the form is successfully submitted. The form processing views all adhere to the practice of POST-redirect-GET for submitting changes, so that refreshing the final page won't result in form re-submission. You can either define this as a class property, or override the `get_success_url()` method, as we're doing here. In this case we're using the `reverse` function to calculate the URL of the contact list.

Context Variables in Class Based Views

The collection of values available to a template when it's rendered is referred to as the Context. The Context is a combination of information supplied by the view and information from [context processors](https://docs.djangoproject.com/en/1.5/ref/templates/api/#subclassing-context-requestcontext) (<https://docs.djangoproject.com/en/1.5/ref/templates/api/#subclassing-context-requestcontext>).

When you're using built in generic views, it's not obvious what values are available to the context. With some practice you'll discover they're pretty consistent – `form`, `object`, and `object_list` are often used – but that doesn't help when you're just starting off. Luckily, the documentation for this is much improved with Django 1.5.

In class based views, the `get_context_data()` method is used to add information to the context. If you override this method, you usually want to accept `**kwargs`, and call the super class.

The template is slightly more involved than the list template, but not much. Our `edit_contact.html` will look something like this.

```
<h1>Add Contact</h1>

<form action="{% url contacts-new %}" method="POST">
    {% csrf_token %}
    <ul>
        {{ form.as_ul }}
    </ul>
    <input type="submit" value="Save" />
</form>

<a href="{% url contacts-list %}">back to list</a>
```

A few things to note:

- The `form` in the context is the [Django Form](https://docs.djangoproject.com/en/1.5/topics/forms/i) (<https://docs.djangoproject.com/en/1.5/topics/forms/i>) for our model. Since we didn't specify one, Django made one for us. How thoughtful.
- If the just do `{{ form }}` we'll get table rows; adding `.as_ul` formats the inputs for an unordered list. Try `.as_p` instead to see what you get.
- When we output the form, it only includes our fields, not the surrounding `<form>` tag or the submit button, so we have to add those.
- The `{% csrf_token %}` tag inserts a hidden input that Django uses to verify that the request came from your project, and isn't a forged cross-site request. Try omitting it: you can still access the page, but when you go to submit the form, you'll get an error.
- We're using the `url` template tag to generate the link back to the contact list. Note that `contacts-list` is the name of our view from the URL configuration. By using `url` instead of an explicit path, we don't have to worry about a link breaking. `url` in templates is equivalent to `reverse` in Python code.

Finally, let's configure the URL by adding the following line to our `urls.py` file:

```
url(r'^new$', contacts.views.CreateContactView.as_view(),
    name='contacts-new',),
```

You can go to `http://localhost:8000/new` to create new contacts

3.8 Testing Your Views

So far our views have been pretty minimal: they leverage Django's generic views, and contain very little of our own code or logic. One perspective is that this is how it should be: a view takes a request, and returns a response, delegating

the issue of validating input to forms, and business logic to model methods. This is a perspective that I subscribe to. The less logic contained in views, the better.

However, there is code in views that should be tested, either by unit tests or integration tests. The distinction is important: unit tests are focused on testing a single unit of functionality. When you're writing a unit test, the assumption is that everything else has its own tests and is working properly. Integration tests attempt to test the system from end to end, so you can ensure that the points of integration are functioning properly. Most systems have both.

Django has two tools that are helpful for writing unit tests for views: the `TestClient` (<https://docs.djangoproject.com/en/1.5/topics/testing/overview/#module-django.test.client>) and the `RequestFactory` (<https://docs.djangoproject.com/en/1.5/topics/testing/advanced/#django.test.client.RequestFactory>). They have similar APIs, but approach things differently. The `TestClient` takes a URL to retrieve, and resolves it against your projects' URL configuration. It then creates a test request, and passes that request through your view, returning the `Response`. The fact that it requires you to specify the URL ties your test to the URL configuration of your project.

The `RequestFactory` has the same API: you specify the URL you want to retrieve and any parameters or form data. But it doesn't actually resolve that URL: it just returns the `Request` object. You can then manually pass it to your view and test the result.

In practice, `RequestFactory` tests are usually somewhat faster than the `TestClient`. This isn't a big deal when you have five tests, but it is when you have 500 or 5,000. Let's look at the same test written with each tool.

```
from django.test.client import Client
from django.test.client import RequestFactory
...
class ContactListViewTests(TestCase):
    """Contact list view tests."""

    def test_contacts_in_the_context(self):

        client = Client()
        response = client.get('/')

        self.assertEqual(list(response.context['object_list']), [])

        Contact.objects.create(first_name='foo', last_name='bar')
        response = client.get('/')
        self.assertEqual(response.context['object_list'].count(), 1)

    def test_contacts_in_the_context_request_factory(self):

        factory = RequestFactory()
        request = factory.get('/')

        response = ListContactView.as_view()(request)

        self.assertEqual(list(response.context_data['object_list']), [])

        Contact.objects.create(first_name='foo', last_name='bar')
        response = ListContactView.as_view()(request)
        self.assertEqual(response.context_data['object_list'].count(), 1)
```

3.9 Integration Tests

Django 1.4 adds a new `TestCase` base class, the `LiveServerTestCase` (<https://docs.djangoproject.com/en/1.5/topics/testing/overview/#liveserver testcase>). This is very much what it sounds like: a test case that runs against a live server. By default Django will start the development server for you

when it runs these tests, but they can also be run against another server. [Selenium](http://seleniumhq.org/) (<http://seleniumhq.org/>) is a package commonly used for writing tests that drive a web browser, and that's what we'll use for our integration tests.

```
(tutorial)$ pip install selenium
```

We're going to write a couple of tests for our views:

- one that creates a Contact and makes sure it's listed
- one that makes sure our "add contact" link is visible and linked on the list page
- and one that actually exercises the add contact form, filling it in and submitting it.

```
from django.test import LiveServerTestCase
from selenium.webdriver.firefox.webdriver import WebDriver
...
class ContactListIntegrationTests(LiveServerTestCase):

    @classmethod
    def setUpClass(cls):
        cls.selenium = WebDriver()
        super(ContactListIntegrationTests, cls).setUpClass()

    @classmethod
    def tearDownClass(cls):
        cls.selenium.quit()
        super(ContactListIntegrationTests, cls).tearDownClass()

    def test_contact_listed(self):

        # create a test contact
        Contact.objects.create(first_name='foo', last_name='bar')

        # make sure it's listed as <first> <last> on the list
        self.selenium.get('%s%s' % (self.live_server_url, '/'))
        self.assertEqual(
            self.selenium.find_elements_by_xpath('//ul/li')[0].text,
            'foo bar'
        )

    def test_add_contact_linked(self):

        self.selenium.get('%s%s' % (self.live_server_url, '/'))
        self.assert_(
            self.selenium.find_element_by_link_text('add contact')
        )

    def test_add_contact(self):

        self.selenium.get('%s%s' % (self.live_server_url, '/'))
        self.selenium.find_element_by_link_text('add contact').click()

        self.selenium.find_element_by_id('id_first_name').send_keys('test')
        self.selenium.find_element_by_id('id_last_name').send_keys('contact')
        self.selenium.find_element_by_id('id_email').send_keys('test@example.com')

        self.selenium.find_element_by_xpath("//input[@type='submit']").click()
        self.assertEqual(
            self.selenium.find_elements_by_xpath('//ul/li')[-1].text,
            'test contact'
        )
```

)

Note that Selenium allows us to find elements in the page, inspect their state, click them, and send keystrokes. In short, it's like we're controlling the browser. In fact, if you run the tests now, you'll see a browser open when the tests run.

3.10 Edit Views

In addition to creating Contacts, we'll of course want to edit them. As with the List and Create views, Django has a generic view we can use as a starting point.

```
class UpdateContactView(UpdateView):
```

```
    model = Contact
    template_name = 'edit_contact.html'

    def get_success_url(self):
        return reverse('contacts-list')
```

- we can re-use the same template
- but how does it know which contact to load?
- we need to either: provide a pk/slug, or override `get_object()`.
- we'll provide pk in the URL

```
url(r'^edit/(?P<pk>\d+)/$', contacts.views.UpdateContactView.as_view(),
    name='contacts-edit',),
```

We'll update the contact list to include an edit link next to each contact.

```
<h1>Contacts</h1>
```

```
<ul>
```

```
    {% for contact in object_list %}
        <li>{{ contact }}
            (<a href="{% url contacts-edit pk=contact.id %}">edit</a>)
        </li>
    {% endfor %}
</ul>
```

```
<a href="{% url contacts-new %}">add contact</a>
```

Note the use of `pk=contact.id` in the `{% url %}` tag to specify the arguments to fill into the URL pattern.

If you run the server now, you'll see an edit link. Go ahead and click it, and try to make a change. You'll notice that instead of editing the existing record, it creates a new one. Sad face.

If we look at the source of the edit HTML, we can easily see the reason: the form targets `/new`, not our edit URL. To fix this – and still allow re-using the template – we're going to add some information to the template context.

The template context is the information available to a template when it's rendered. This is a combination of information you provide in your view – either directly or indirectly – and information added by `context processors` (<https://docs.djangoproject.com/en/1.5/ref/templates/api/#subclassing-context-requestcontext>), such as the location for static media and current locale. In order to use the same template for add and edit, we'll add information about where the form should redirect to the context.

```

class CreateContactView(CreateView):

    model = Contact
    template_name = 'edit_contact.html'

    def get_success_url(self):
        return reverse('contacts-list')

    def get_context_data(self, **kwargs):

        context = super(CreateContactView, self).get_context_data(**kwargs)
        context['action'] = reverse('contacts-new')

        return context

class UpdateContactView(UpdateView):

    model = Contact
    template_name = 'edit_contact.html'

    def get_success_url(self):
        return reverse('contacts-list')

    def get_context_data(self, **kwargs):

        context = super(UpdateContactView, self).get_context_data(**kwargs)
        context['action'] = reverse('contacts-edit',
                                   kwargs={'pk': self.get_object().id})

        return context

```

We also update the template to use that value for the action and change the title based on whether or not we've previously saved.

```

{% if contact.id %}
<h1>Edit Contact</h1>
{% else %}
<h1>Add Contact</h1>
{% endif %}

<form action="{% action %}" method="POST">

```

You may wonder where the `contact` value in the contact comes from: the class based views that wrap a single object (those that take a primary key or slug) expose that to the context in two different ways: as a variable named `object`, and as a variable named after the model class. The latter often makes your templates easier to read and understand later. You can customize this name by overriding `get_context_object_name` on your view.

Made a Change? Run the Tests.

We've just made a change to our `CreateContactView`, which means this is a perfect time to run the tests we wrote. Do they still pass? If not, did we introduce a bug, or did the behavior change in a way that we expected? (Hint: We changed how the contact list is rendered, so our tests that just expect the name there are going to fail. This is a case where you'd need to update the test case, but it also demonstrates how integration tests can be fragile.)

3.11 Deleting Contacts

The final view for our basic set of views is delete. The generic deletion view is very similar to the edit view: it wraps a single object and requires that you provide a URL to redirect to on success. When it processes a HTTP GET request, it displays a confirmation page, and when it receives an HTTP DELETE or POST, it deletes the object and redirects to the success URL.

We add the view definition to `views.py`:

```
class DeleteContactView(DeleteView):

    model = Contact
    template_name = 'delete_contact.html'

    def get_success_url(self):
        return reverse('contacts-list')
```

And create the template, `delete_contact.html`, in our templates directory.

```
<h1>Delete Contact</h1>

<p>Are you sure you want to delete the contact {{ contact }}?</p>

<form action="{% url contacts-delete pk=contact.id %}" method="POST">
    {% csrf_token %}

    <input type="submit" value="Yes, delete." />
    <a href="{% url contacts-list %}">No, cancel.</a>
</form>
```

Of course we need to add this to the URL definitions:

```
url(r'^delete/(?P<pk>\d+)/$', contacts.views.DeleteContactView.as_view(),
    name='contacts-delete',),
```

And we'll add the link to delete to the edit page.

```
{% if contact.id %}
<a href="{% url contacts-delete pk=contact.id %}">Delete</a>
{% endif %}
```

3.12 Detail View

Finally, let's go ahead and add a detail view for our Contacts. This will show the details of the Contact: not much right now, but we'll build on this shortly. Django includes a generic `DetailView`: think of it as the single serving `ListView`.

```
class ContactView(DetailView):

    model = Contact
    template_name = 'contact.html'
```

Again, the template is pretty straight forward; we create `contact.html` in the templates directory.

```
<h1>{{ contact }}</h1>

<p>Email: {{ contact.email }}</p>
```


And add the URL mapping:

```
url(r'^(?P<pk>\d+)/$', contacts.views.ContactView.as_view(),
    name='contacts-view',),
```

We're also going to add a method to our Contact model, `get_absolute_url`. `get_absolute_url` is a Django convention for obtaining the URL of a single model instance. In this case it's just going to be a call to `reverse`, but by providing this method, our model will play nicely with other parts of Django.

```
class Contact(models.Model):
    ...
    def get_absolute_url(self):
        return reverse('contacts-view', kwargs={'pk': self.id})
```

And we'll add the link to the contact from the contact list.

```
<li><a href="{% contact.get_absolute_url %}">{{ contact }}</a>
    (<a href="{% url contacts-edit pk=contact.id %}">edit</a>)
</li>
{% endfor %}
</ul>
```

3.13 Review

- Views take an [HttpRequest](https://docs.djangoproject.com/en/1.5/ref/request-response/#httprequest-objects) (<https://docs.djangoproject.com/en/1.5/ref/request-response/#httprequest-objects>) and turn it into an [HttpResponse](https://docs.djangoproject.com/en/1.5/ref/request-response/#httpresponse-objects) (<https://docs.djangoproject.com/en/1.5/ref/request-response/#httpresponse-objects>)
- Django introduced generic class-based views with Django 1.3
- These let you create reusable, composable views
- URLs are defined in the `urls.py` file in your project
- Naming URLs lets you calculate the URL for redirection, linking, etc, making it easier to change URLs, if needed
- [RequestFactory](https://docs.djangoproject.com/en/1.5/topics/testing/advanced/#django.test.client.RequestFactory) (<https://docs.djangoproject.com/en/1.5/topics/testing/advanced/#django.test.client.RequestFactory>) allows you to create Requests for testing Views with
- [LiveServerTestCase](https://docs.djangoproject.com/en/1.5/topics/testing/overview/#liveserver testcase) (<https://docs.djangoproject.com/en/1.5/topics/testing/overview/#liveserver testcase>) provides the infrastructure for writing integration tests

FORM BASICS

Up until this point we've been using forms without really needing to be aware of it. A [Django Form](https://docs.djangoproject.com/en/1.5/topics/forms/) (<https://docs.djangoproject.com/en/1.5/topics/forms/>) is responsible for taking some user input, validating it, and turning it into Python objects. They also have some handy rendering methods, but I consider those sugar: the real power is in making sure that input from your users is what it says it is.

The [Generic Views](https://docs.djangoproject.com/en/1.5/topics/class-based-views/) (<https://docs.djangoproject.com/en/1.5/topics/class-based-views/>), specifically the ones we've been using, all operate on a particular model. Django is able to take the model definition that we've created and extrapolate a Form from it. Django can do this because both Models and Forms are constructed of fields that have a particular type and particular validation rules. Models use those fields to map data to types that your database understands; Forms use them to map input to Python types ¹. Forms that map to a particular Model are called [ModelForms](https://docs.djangoproject.com/en/1.5/topics/forms/modelforms/) (<https://docs.djangoproject.com/en/1.5/topics/forms/modelforms/>); you can think of them as taking user input and transforming it into an instance of a Model.

4.1 Adding Fields to the Form

So what if we want to add a field to our form? Say, we want to require confirmation of the email address. In that case we can create a new form, and override the default used by our views.

First, in the `contacts` app directory, we'll create a new file, `forms.py`.

```
from django import forms
from django.core.exceptions import ValidationError

from contacts.models import Contact

class ContactForm(forms.ModelForm):

    confirm_email = forms.EmailField(
        "Confirm email",
        required=True,
    )

    class Meta:
        model = Contact

    def __init__(self, *args, **kwargs):

        if kwargs.get('instance'):
            email = kwargs['instance'].email
```

¹ While I'm referring to them both as fields, they're really completely different implementations. But the analogy holds.

```
kwargs.setdefault('initial', {})[confirm_email] = email

return super(ContactForm, self).__init__(*args, **kwargs)
```

Here we're creating a new `ModelForm`; we associate the form with our model in the `Meta` inner class.

We're also adding an additional field, `confirm_email`. This is an example of a field declaration in a model. The first argument is the label, and then there are additional keyword arguments; in this case, we simply mark it required.

Finally, in the constructor we mutate the `initial` kwarg. `initial` is a dictionary of values that will be used as the default values for an `unbound form` (<https://docs.djangoproject.com/en/1.5/ref/forms/api/#ref-forms-api-bound-unbound>). Model Forms have another kwarg, `instance`, that holds the instance we're editing.

4.2 Overriding the Default Form

We've defined a form with the extra field, but we still need to tell our view to use it. You can do this in a couple of ways, but the simplest is to set the `form_class` property on the View class. We'll add that property to our `CreateContactView` and `UpdateContactView` in `views.py`.

```
import forms
...
class CreateContactView(CreateView):

    model = Contact
    template_name = 'edit_contact.html'
    form_class = forms.ContactForm

class UpdateContactView(UpdateView):

    model = Contact
    template_name = 'edit_contact.html'
    form_class = forms.ContactForm
```

If we fire up the server and visit the edit or create pages, we'll see the additional field. We can see that it's required, but there's no validation that the two fields match. To support that we'll need to add some custom validation to the Form.

4.3 Customizing Validation

Forms have two different phases of validation: field and form. All the fields are validated and converted to Python objects (if possible) before form validation begins.

Field validation takes place for an individual field: things like minimum and maximum length, making sure it looks like a URL, and date range validation are all examples of field validation. Django doesn't guarantee that field validation happens in any order, so you can't count on other fields being available for comparison during this phase.

Form validation, on the other hand, happens after all fields have been validated and converted to Python objects, and gives you the opportunity to do things like make sure passwords match, or in this case, email addresses.

Form validation takes place in a form's `clean()` method.

```
class ContactForm(forms.ModelForm):
...
    def clean(self):
```

```

    if (self.cleaned_data.get('email') !=
        self.cleaned_data.get('confirm_email')):

        raise ValidationError(
            "Email addresses must match."
        )

    return self.cleaned_data

```

When you enter the `clean` method, all of the fields that validated are available in the `cleaned_data` dictionary. The `clean` method may add, remove, or modify values, but **must** return the dictionary of cleaned data. `clean` may also raise a `ValidationError` if it encounters an error. This will be available as part of the forms' errors property, and is shown by default when you render the form.

Note that I said `cleaned_data` contains all the fields *that validated*. That's because form-level validation **always** happens, even if no fields were successfully validated. That's why in the `clean` method we use `cleaned_data.get('email')` instead of `cleaned_data['email']`.

If you visit the create or update views now, we'll see an extra field there. Try to make a change, or create a contact, without entering the email address twice.

4.4 Controlling Form Rendering

Our templates until now look pretty magical when it comes to forms: the extent of our HTML tags has been something like:

```

<form action="{{ action }}" method="POST">
    {% csrf_token %}
    <ul>
        {{ form.as_ul }}
    </ul>
    <input type="submit" value="Save" />
</form>

```

We're living at the whim of `form.as_ul`, and it's likely we want something different.

Forms have three pre-baked output formats: `as_ul`, `as_p`, and `as_table`. If `as_ul` outputs the form elements as the items in an unordered list, it's not too mysterious as `as_p` and `as_table` do. Often, though, you need more control. For those cases, you can take full control. First, a form is iterable; try replacing your call to `{{ form.as_ul }}` with this:

```

{% for field in form %}
    {{ field }}
{% endfor %}

```

As you can see, `field` renders as the input for each field in the form. When you iterate over a Form, you're iterating over a sequence of `BoundField` (<https://docs.djangoproject.com/en/1.5/ref/forms/api/#django.forms.BoundField>) objects. A `BoundField` wraps the field definition from your Form (or derived from the `ModelForm`) along with any data and error state it may be bound to. This means it has some properties that are handy for customizing rendering.

In addition to supporting iteration, you can access an individual `BoundField` directly, treating the Form like a dictionary:

```

{{ form.email }}

```

Dictionary!?!

That may not look like a dictionary access, but remember that Django templates are quite restrictive in their syntax. Writing `foo.bar` will look for a property `bar` on `foo`, and if it's callable, call it. If it doesn't find a property, it'll map that to something like `foo['bar']`. So when it comes to writing Django templates, dictionary elements act just like properties.

Consider the following alternative to `edit_contact.html`.

```
{% if contact.id %}
<h1>Edit Contact</h1>
{% else %}
<h1>Add Contact</h1>
{% endif %}

<form action="{{ action }}" method="POST">
    {% csrf_token %}

    {% for field in form %}
    <div id="{{ field.auto_id }}_container">
        {{ field.help_text }}
        <div>
            {{ field.label_tag }} {{ field }}
        </div>
        <div id="{{ field.auto_id }}_errors">
            {{ field.errors }}
        </div>
    </div>
    {% endfor %}

    <input type="submit" value="Save" />
</form>

{% if contact.id %}
<a href="{% url contacts-edit-addresses pk=contact.id %}">
    Edit Addresses
</a>
<a href="{% url contacts-delete pk=contact.id %}">Delete</a>
{% endif %}

<a href="{% url contacts-list %}">back to list</a>
```

In this example we see a few different things at work:

- `field.auto_id` to get the automatically generated field ID
- Combining that ID with `_container` and `_errors` to give our related elements names that consistently match
- Using `field.label_tag` to generate the label. `label_tag` adds the appropriate `for` property to the tag, too. For the `last_name` field, this looks like:

```
<label for="id_last_name">Last name</label>
```
- Using `field.errors` to show the errors in a specific place. The Django Form documentation has details on further customizing [how errors are displayed](https://docs.djangoproject.com/en/1.5/ref/forms/api/#how-errors-are-displayed) (<https://docs.djangoproject.com/en/1.5/ref/forms/api/#how-errors-are-displayed>).
- Finally, `field.help_text`. You can specify a `help_text` keyword argument to each field when creating

your form, which is accessible here. Defining that text in the Form definition is desirable because you can easily mark it up for translation.

4.5 Testing Forms

It's easy to imagine how you'd use the `LiveServerTestCase` to write an integration test for a Form. But that wouldn't just be testing the Form, that'd be testing the View, the URL configuration, and probably the Model (in this case, at least). We've built some custom logic into our form's validator, and it's important to test that and that alone. Integration tests are invaluable, but when they fail there's more than one suspect. I like tests that fail with a single suspect.

Writing unit tests for a Form usually means crafting some dictionary of form data that meets the starting condition for your test. Some Forms can be complex or long, so we can use a helper to generate the starting point from the Form's initial data.

Rebar is a collection of utilities for working with Forms. We'll install Rebar so we can use the testing utilities.

```
(tutorial)$ pip install rebar
```

Then we can write a unit test that tests two cases: success (email addresses match) and failure (they do not).

```
from rebar.testing import flatten_to_dict
from contacts import forms
...
class EditContactFormTests(TestCase):

    def test_mismatch_email_is_invalid(self):

        form_data = flatten_to_dict(forms.ContactForm())
        form_data['first_name'] = 'Foo'
        form_data['last_name'] = 'Bar'
        form_data['email'] = 'foo@example.com'
        form_data['confirm_email'] = 'bar@example.com'

        bound_form = forms.ContactForm(data=form_data)
        self.assertFalse(bound_form.is_valid())

    def test_same_email_is_valid(self):

        form_data = flatten_to_dict(forms.ContactForm())
        form_data['first_name'] = 'Foo'
        form_data['last_name'] = 'Bar'
        form_data['email'] = 'foo@example.com'
        form_data['confirm_email'] = 'foo@example.com'

        bound_form = forms.ContactForm(data=form_data)
        self.assertTrue(bound_form.is_valid())
```

An interesting thing to note here is the use of the `is_valid()` method. We could just as easily introspect the `errors` property that we used in our template above, but in this case we just need a Boolean answer: is the form valid, or not? Note that we do need to provide a first and last name, as well, since those are required fields.

4.6 Review

- Forms take user input, validate it, and convert it to Python objects

- Forms are composed of Fields, just like Models
- Fields have validation built in
- You can customize per-field validation, as well as form validation
- If you need to compare fields to one another, you need to implement the `clean` method
- Forms are iterable over, and support dictionary-like access to, the bound fields
- A Bound Field has properties and methods for performing fine-grained customization of rendering.
- Forms are unit testable; Rebar has some utilities to help with testing large forms.

RELATED MODELS

5.1 Adding Relationships

We have a basic email address book at this point, but there's other information we might want to track for our contacts. Mailing addresses, for example. A single Contact may have multiple addresses associated with them, so we'll store this in a separate table, allowing us to have multiple addresses for each Contact.

```
class Address(models.Model):

    contact = models.ForeignKey(Contact)
    address_type = models.CharField(
        max_length=10,
    )

    address = models.CharField(
        max_length=255,
    )
    city = models.CharField(
        max_length=255,
    )
    state = models.CharField(
        max_length=2,
    )
    postal_code = models.CharField(
        max_length=20,
    )

    class Meta:
        unique_together = ('contact', 'address_type',)
```

Django provides three types of fields for relating objects to each other: `ForeignKey` for creating one to many relationships, `ManyToManyField` for relating many to many, and `OneToOneField` for creating a one to one relationship. You define the relationship in one model, but it's accessible from the other side, as well.

Sync up the database to create the table, and then start the shell so we can explore this.

```
(tutorial)$ python manage.py syncdb
Creating tables ...
Creating table contacts_address
Installing custom SQL ...
Installing indexes ...
Installed 0 object(s) from 0 fixture(s)
```

Now that we have the model created, we can again play with it using the interactive shell.

```
(tutorial)$ python manage.py shell
Python 2.7.3 (default, Aug 9 2012, 17:23:57)
[GCC 4.7.1 20120720 (Red Hat 4.7.1-5)] on linux2
Type "help", "copyright", "credits" or "license" for more information.
(InteractiveConsole)
>>> from contacts.models import Contact, Address
>>> nathan = Contact.objects.create(first_name='Nathan', email='nathan@yergler.net')
>>> nathan.address_set.all()
[]
>>> nathan.address_set.create(address_type='home', city='San Francisco', state='CA', postal_code='94111')
<Address: Address object>
>>> nathan.address_set.create(address_type='college', address='354 S. Grant St.', city='West Lafayette', state='IN', postal_code='46788')
<Address: Address object>
>>> nathan.address_set.all()
[<Address: Address object>, <Address: Address object>]
>>> nathan.address_set.filter(address_type='college')
<Address: Address object>
>>> Address.objects.filter(contact__first_name='Nathan')
[<Address: Address object>, <Address: Address object>]
```

As you can see, even though we defined the relationship between Contacts and Addresses on the Address model, Django gives us a way to access things in the reverse direction. We can also use the double underscore notation to filter Addresses or Contacts based on the related objects.

Let's go ahead and add address display to our contacts. We'll add the list of all Addresses to the Contact detail view in `contact.html`.

```
<h1>{{ contact }}</h1>

<p>Email: {{ contact.email }}</p>

<ul>
{% for address in contact.address_set.all %}
    <li>{{ address.address }}<br/>
        {{ address.city }} {{ address.state }}<br/>
        {{ address.postal_code }}
    </li>
{% endfor %}
</ul>
```

5.2 Editing Related Objects

So how do we go about editing addresses for our contacts? You can imagine creating another `CreateView` like we did for Contacts, but the question remains: how do we wire the new Address to our Contact? We could conceivably just pass the Contact's ID through the the HTML, but we'd still need to validate that it hadn't been tampered with when we go to create the Address.

To deal with this, we'll create a form that understands the relationship between Contacts and Addresses.

The editing interface we're going to build for Addresses is one that allows you to edit all the addresses for a Contact at once. To do this, we'll need to create a [FormSet](https://docs.djangoproject.com/en/1.5/topics/forms/formsets/) (https://docs.djangoproject.com/en/1.5/topics/forms/formsets/) that handles all the Addresses for a single Contact. A FormSet is an object that manages multiple copies of the same Form (or `ModelForm`) in a single page. The [Inline FormSet](https://docs.djangoproject.com/en/1.5/topics/forms/modelforms/#inline-formsets) (https://docs.djangoproject.com/en/1.5/topics/forms/modelforms/#inline-formsets) does this for a set of objects (in this case Addresses) that share a common related object (in this case the Contact).

Because formsets are somewhat complex objects, Django provides factory functions that create the class for you. We'll add a call to the factory to our `forms.py` file.

```
from django.forms.models import inlineformset_factory
...

# inlineformset_factory creates a Class from a parent model (Contact)
# to a child model (Address)
ContactAddressFormSet = inlineformset_factory(
    Contact,
    Address,
)
```

When we create the view, we'll need to specify that this is the form we want to use, instead of having Django create one for us.

```
class EditContactAddressView(UpdateView):

    model = Contact
    template_name = 'edit_addresses.html'
    form_class = forms.ContactAddressFormSet

    def get_success_url(self):

        # redirect to the Contact view.
        return self.get_object().get_absolute_url()
```

Note that even though we're editing Addresses with this view, we still have `model` set to `Contact`. This is because an inline formset takes the parent object as its starting point.

Once again, this needs to be wired up into the URL configuration.

```
url(r'^edit/(?P<pk>\d+)/addresses$', contacts.views.EditContactAddressView.as_view(),
    name='contacts-edit-addresses',),
```

And we have a simple template.

```
<h1>Edit Addresses</h1>

<p>Editing addresses for {{ contact }}</p>

<form action="{% url contacts-edit-addresses pk=contact.id %}"
    method="POST">
    {% csrf_token %}
    {{ form.management_form }}
    {% for address_form in form %}

        <ul>
            {{ address_form.as_ul }}
        </ul>

    {% endfor %}

    <input type="submit" value="Save" />
</form>
```

There are two new things in this template, both related to the fact we're using a formset instead of a form. First, there's a reference to `form.management_form`. This is a set of hidden fields that provide some accounting information to Django: how many forms did we start with, how many empty ones are there, etc. If Django can't find this information when you POST the form, it will raise an exception.

Second, we're iterating over `form` instead of just outputting it (`for address_form in form`). Again, this is because `form` here is a `formset` instead of a single form. When you iterate over a `formset`, you're iterating over the individual forms in it. These individual forms are just “normal” `ModelForm` instances for each `Address`, so you can apply the same output techniques you would normally use.