

วิศวกรรมซอฟต์แวร์

Software Engineering

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Test-Driven Development

Testing a Simple Home Page with Unit Tests

PART II

Software Testing & TDD

Test-Driven Development

Our First Django App, and Our First Unit Test

- Django encourages you to structure your code into apps.

- One project can have many apps.

- Let's start an app for our to-do lists:

```
$ python manage.py startapp lists
```

```
superlists/
├── db.sqlite3
├── functional_tests_firefox.py
├── lists
│   ├── admin.py
│   ├── apps.py
│   ├── __init__.py
│   ├── migrations
│   │   └── __init__.py
│   ├── models.py
│   ├── tests.py
│   └── views.py
├── manage.py
└── superlists
    ├── __init__.py
    ├── __pycache__
    ├── settings.py
    ├── urls.py
    └── wsgi.py
```

Unit Tests, and How They Differ from Functional Tests

- The basic distinction is that ...
 - **Functional tests** test the application from the outside, from the point of view of the *user*. (high level)
 - **Unit tests** test the application from the inside, from the point of view of the *programmer*. (low level)
- The application will be covered by both types of test.
- The **workflow** will look a bit like this.

Unit Tests, and How They Differ from Functional Tests



1. Write a **functional test**, describing the new functionality from the user's point of view.
2. Once we have a functional test that fails, **write code** that can get it to pass (or at least to get past its current failure). We now **use** one or more **unit tests** to define how we want our code to behave—the idea is that each line of production code we write should be tested by (at least) one of our unit tests.
3. Once we have a failing unit test, we **write** the smallest amount of **application code** we can, just enough to get the unit test to pass. We may **iterate between steps 2 and 3** a few times, until we think the functional test will get a little further.
4. Now we can **rerun** our **functional tests** and see if they pass, or get a little further. That may prompt us to write some new unit tests, and some new code, and so on.

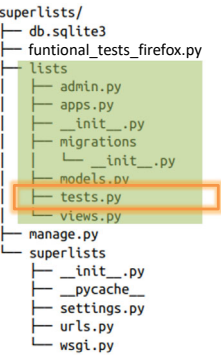
Unit Testing in Django

list/test.py

```
from django.test import TestCase
# Create your tests here.
```

Django suggested we use a **special version of TestCase**. It's an augmented version of the standard unittest.TestCase, with some additional Django-specific features.

- First, let's see **how** the **unit test** will definitely **be run** by our automated test runner.
 - In the case of `functional_tests_firefox.py`, we're **running it directly**.
 - But this **file made by Django** is a bit more like magic.
- Let's make a deliberately silly failing test:



```
from django.test import TestCase
```

```
class SmokeTest(TestCase):
    def test_bad_maths(self):
        self.assertEqual(1 + 1, 3)
```

- Let's invoke this mysterious Django test runner.

```
$ python manage.py test
Creating test database for alias 'default'...
Found 1 test(s).
System check identified no issues (0 silenced).
```

Run it from 'superlists' directory

```
FAIL: test_bad_maths (lists.tests.SmokeTest)
Traceback (most recent call last):
  File "D:\somkiat\src\SE\Lecture\superlists\lists\tests.py", line 6,
    in test_bad_maths
        self.assertEqual(1 + 1, 3)
AssertionError: 2 != 3

Ran 1 test in 0.001s

FAILED (failures=1)
Destroying test database for alias 'default'...
```

Unit Testing in Django

- This is a good point for a **commit**.

Run it from 'superlists' directory

```
$ git status # should show you lists is untracked
$ git add lists
$ git diff --staged # will show you the diff that you're about to commit
$ git commit -m "Add app for lists, with deliberately failing unit test"
```

The **-m flag** lets you **pass in a commit message** at the command line, so you don't need to use an editor.
The key rule is: **make sure** you always **review** what you're about to commit **before you do it**.

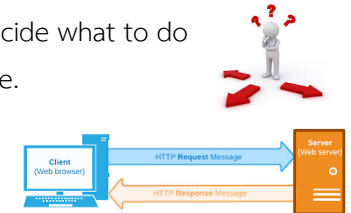
Django's MVC, URLs, and View Functions

- Django** is structured along a classic Model-View-Controller (MVC) pattern.

- As with any web server, **Django's** main job is to decide what to do *when a user asks for a particular URL* on our site.

- Django's workflow goes something like this:

1. An **HTTP request** comes in for a particular URL.
2. Django uses some rules to decide **which view function** should deal with the request (this is referred to as **resolving the URL**).
3. The view function processes the request and **returns** an **HTTP response**.



Django's MVC, URLs, and View Functions

- We want to test **two** things:
 - Can we **resolve** the URL for the root of the site ("/") to a particular view function we've made?
 - Can we make this view function **return** some **HTML** which will get the functional test to pass?

```
from django.urls import resolve
from django.test import TestCase
from lists.views import home_page
```

Open up `lists/tests.py`, and change our silly test to something like this:

```
class HomePageTest(TestCase):

    def test_root_url_resolves_to_home_page_view(self):
        found = resolve('/')
        self.assertEqual(found.func, home_page)
```

We're **checking that** `resolve`, when called with `"/"`, the root of the site, **finds a function** called `home_page`.

`resolve` is the function Django uses internally to **resolve URLs** and **find** what **view function** they should **map to**.

It's the **view function** we're **going to write next**, which will actually **return the HTML** we want.

You can see from the import that we're **planning to store it in** `lists/views.py`.

- When we run the tests ...

```
$ python manage.py test
ImportError: cannot import name 'home_page'
```

View Functions

- Since we're learning and only just starting out the TDD ...
 - We only allow ourselves to change (or add) one line of code at a time—and each time, we make just the minimal change required to address the current test failure.
- Our current test **failure**: Cannot import `home_page` from `lists.views`.
 - Let's fix that—and only that.

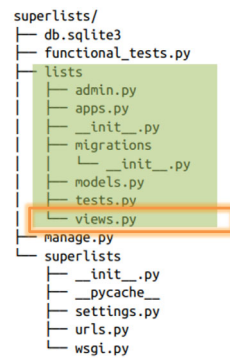
```
from django.shortcuts import render
```

```
# Create your views here.
```

```
home_page = None
```

list/view.py

- Then run the test again



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\$ python manage.py test

Creating test database for alias 'default'...
Found 1 test(s).
System check identified no issues (0 silenced).
E

Reading Tracebacks

The next thing to double-check is:
which test is failing?
Is it definitely the one we expected—that is, **the one we just wrote?**
In this case, the answer is **yes**.

ERROR: test_root_url_resolves_to_home_page_view (lists.tests.HomePageTest)

Traceback (most recent call last):

File "D:\somkiat\src\SE\Lecture\superlists\lists\tests.py", line 8, in test_root_url_resolves_to_home_page_view

found = resolve('/')

File "C:\Users\w_som\.virtualenvs\superlists\lib\site-packages\django\urls\base.py", line 24, in resolve

return get_resolver(urlconf).resolve(path)

File "C:\Users\w_som\.virtualenvs\superlists\lib\site-packages\django\urls\resolvers.py", line 725, in resolve

raise Resolver404({'tried': tried, 'path': new_path})

django.urls.exceptions.Resolver404: {'tried': [[<URLResolver <URLPattern list> (admin:admin) 'admin/'>]], 'path': ''}

The first place you look is usually **the error itself**.
It will let you **identify the problem** immediately.
But **sometimes**, like in this case, it's **not** quite **self-evident**.

Ran 1 test in 0.004s

FAILED (errors=1)

Destroying test database for alias 'default'...

\$ python manage.py test

Reading Tracebacks

Creating test database for alias 'default'...
Found 1 test(s).
System check identified no issues (0 silenced).
E

ERROR: test_root_url_resolves_to_home_page_view (lists.tests.HomePageTest)

Traceback (most recent call last):

File "D:\somkiat\src\SE\Lecture\superlists\lists\tests.py", line 8, in test_root_url_resolves_to_home_page_view

found = resolve('/')

File "C:\Users\w_som\.virtualenvs\superlists\lib\site-packages\django\urls\base.py", line 24, in resolve

return get_resolver(urlconf).resolve(path)

File "C:\Users\w_som\.virtualenvs\superlists\lib\site-packages\django\urls\resolvers.py", line 725, in resolve

raise Resolver404({'tried': tried, 'path': new_path})

django.urls.exceptions.Resolver404: {'tried': [[<URLResolver <URLPattern list> (admin:admin) 'admin/'>]], 'path': ''}

Then we look for the place in our **test code** that kicked off the failure.

From the top of the traceback, looking for the filename of the tests file, to check **which test function**, and **what line** of code, the failure is coming from.

In this case it's **the line where we call the resolve function for the "/" URL**.

Ran 1 test in 0.004s

FAILED (errors=1)

Destroying test database for alias 'default'...

The traceback is telling us that, **when trying to resolve "/"**, Django raised a **404 error**—in other words, Django **can't find a URL mapping for "/"**. Let's help it out.

Our tests are telling us that we **need a URL mapping**.

Django uses a file called **urls.py** to map URLs to view functions.

There's a **main urls.py** for the whole site in the **superlists/superlists** folder.

superlists/urls.py

URL configuration for superlists project.

The `urlpatterns` list routes URLs to views. For more information please see: <https://docs.djangoproject.com/en/5.0/topics/http/urls/>

Examples:

Function views

1. Add an import: `from my_app import views`

2. Add a URL to `urlpatterns`: `path('', views.home, name='home')`

Class-based views

1. Add an import: `from other_app.views import Home`

2. Add a URL to `urlpatterns`: `path('', Home.as_view(), name='home')`

Including another URLconf

1. Import the `include()` function: `from django.urls import include, path`

2. Add a URL to `urlpatterns`: `path('blog/', include('blog.urls'))`

```
from django.contrib import admin
from django.urls import path
```

```
urlpatterns = [
    path('admin/', admin.site.urls),
]
```

A url entry defines **which URLs it applies to**, and goes on to say **where it should send those requests**—either **to a view function** you've imported, or maybe **to another urls.py file** somewhere else

Get rid of the admin URL, because we won't be using the Django admin site for now.

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Our tests are telling us that we need a **URL mapping**.

Django uses a file called `urls.py` to map URLs to view functions.

There's a main `urls.py` for the whole site in the `superlists/superlists` folder.

```
"""
URL configuration for superlists project.
"""
from django.urls import path

urlpatterns = [
    path('', views.home_page, name='home'),
]
```

The `urlpatterns` list routes URLs to views. For more information please see:
<https://docs.djangoproject.com/en/5.0/topics/http/urls/>
Examples:
Function views
1. Add an import: `from my_app import views`
2. Add a URL to `urlpatterns`: `path('', views.home, name='home')`
Class-based views
1. Add an import: `from other_app.views import Home`
2. Add a URL to `urlpatterns`: `path('', Home.as_view(), name='home')`
Including another URLconf
1. Import the `include()` function: `from django.urls import include, path`
2. Add a URL to `urlpatterns`: `path('blog/', include('blog.urls'))`

superlists/urls.py

- Run the unit tests again, with `python manage.py test`:

```
[...] That's progress! No longer getting a 404.
```

```
TypeError: view must be a callable or a list/tuple in the case of include().
```

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Unit Testing a View

- Now we will be writing a **test** for our **view**, so that it can be something more than a do-nothing function, and instead be a function that returns a real response with HTML to the browser.
 - Open up `lists/tests.py`, and add a new test method.

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The message is telling us what's going on.

The unit tests have actually **made** the link between the URL `"/` and the `home_page = None` in `lists/views.py`, and are **now complaining** that the `home_page` view is **not callable**.

That gives us a justification for **changing** it from being `None` to being an **actual function**.

Every single code change is driven by the tests!

```
from django.shortcuts import render
```

list/view.py

```
# Create your views here.
```

```
def home_page():
    pass
```

```
$ python manage.py test
```

```
Creating test database for alias 'default'...
```

```
Found 1 test(s).
```

```
System check identified no issues (0 silenced).
```

```
.
```

```
Ran 1 test in 0.001s
```

Our first ever unit test pass!

That's so momentous that I think it's worthy of a **commit**:

```
OK
```

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

```
$ git diff # should show changes to urls.py, tests.py, and views.py
```

```
$ git commit -am "First unit test and url mapping, dummy view"
```

The **a** and **m** flags together

add all changes to tracked files and

uses the commit message from the command line.

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```
from django.urls import resolve
from django.test import TestCase
from django.http import HttpRequest
```

lists/tests.py

```
from lists.views import home_page
```

```
class HomePageTest(TestCase):
```

Create an **HttpRequest** object, which is what Django will see when a user's browser asks for a page.

```
def test_root_url_resolves_to_home_page_view(self):
    found = resolve('/')
    self.assertEqual(found.func, home_page)
```

Pass it to our `home_page` view, which gives us a **response**. This object is an instance of a class called **HttpResponse**

```
def test_home_page_returns_correct_html(self):
    request = HttpRequest()
    response = home_page(request)
    html = response.content.decode('utf8')
    self.assertTrue(html.startswith('<html>'));
    self.assertIn('<title>To-Do lists</title>', html)
    self.assertTrue(html.endswith('</html>'));
```

Then, extract the **.content** of the **response**.

These are the **raw bytes**, the ones and zeros that would be sent down the wire to the user's browser. We call **.decode()** to **convert** them into the **string** of HTML that's being sent to the user.

We want it to start with an `<html>` tag which gets closed at the end.

And we want a `<title>` tag somewhere in the middle, with the words "To-Do lists" in it—because that's what we specified in our functional test.

Let's run the unit tests.

```
TypeError: home_page() takes 0 positional arguments but 1 was given
```

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The Unit-Test/Code Cycle

1. In the terminal, **run** the **unit tests** and see how they fail.
 2. In the editor, make a **minimal code change** to address the current test failure.
- And repeat!
 - The more nervous we are about getting our code right, the **smaller** and more **minimal** we make each code change.
(The idea is to be absolutely sure that each bit of code is justified by a test.)
 - This may seem laborious. But once you get into the swing of things, you'll find yourself coding quickly even if you take microscopic steps.
 - **Let's see how fast** we can get this **cycle** going:

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The Unit-Test/Code Cycle

- Minimal code change:

```
def home_page(request):  
    pass
```

lists/views.py

- Tests:

```
$ python manage.py test  
[...]  
html = response.content.decode('utf8')  
AttributeError: 'NoneType' object has no attribute 'content'  
[...]
```

- Code—we use `django.http.HttpResponse`, as predicted:

```
from django.http import HttpResponse  
  
# Create your views here.  
def home_page(request):  
    return HttpResponse()
```

lists/views.py

- Tests again:

```
[...]  
self.assertTrue(html.startswith('<html>'))  
AssertionError: False is not true  
[...]
```

- Code again:

```
def home_page(request):  
    return HttpResponse('<html>')
```

lists/views.py

- Tests:

```
$ python manage.py test  
[...]  
AssertionError: '<title>To-Do lists</title>' not found in '<html>'  
[...]
```

- Code:

```
def home_page(request):  
    return HttpResponse('<html><title>To-Do lists</title>')
```

lists/views.py

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- Tests—almost there?

```
[...]  
self.assertTrue(html.endswith('</html>'))  
AssertionError: False is not true  
[...]
```

- Come on, one last effort:

```
def home_page(request):  
    return HttpResponse('<html><title>To-Do lists</title></html>')
```

lists/views.py

- Surely?

```
$ python manage.py test  
Creating test database for alias 'default'...  
Found 2 test(s).  
System check identified no issues (0 silenced).  
..
```

Ran 2 tests in 0.002s

OK

Destroying test database for alias 'default'...

Yes!

Now, let's run our functional tests.
Don't forget to **spin up the dev server** again (if not still running).

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- Run functional tests.

```
$ python python_functional_tests_firefox.py
```

```
=====
FAIL: test_can_start_a_list_and_retrieve_it_later
(__main__.NewVisitorTest)
-----
```

```
Traceback (most recent call last):
```

```
File
"D:\somkiat\src\SE\Lecture\superlists\functional_tests_firefox.py",
line 19, in test_can_start_a_list_and_retrieve_it_later
    self.fail('Finish the test!')
AssertionError: Finish the test!
```

```
-----
Ran 1 test in 14.757s
```

```
FAILED (failures=1)
```

Failed?
No, it's just our little reminder.
Yes! We have a web page!

- Commit:

```
$ git diff # should show our new test in tests.py, and the view in views.py
$ git commit -am "Basic view now returns minimal HTML"
```

The Unit-Test/Code Cycle

- Type `git log -oneline`, for a reminder of what we got up to:

```
$ git log -oneline
```

```
ce6363c (HEAD -> master) Basic view now returns minimal HTML
33332ed First unit test and url mapping, dummy view
41dece0 Add app for lists, with deliberately failing unit test
c08183f On branch master
441745d On branch master
```

Useful Commands and Concepts

Running the Django dev server

```
python manage.py runserver
```

Running the functional tests

```
python functional_tests_firefox.py
```

Running the unit tests

```
python manage.py test
```

The unit-test/code cycle

1. Run the unit tests in the terminal.
2. Make a minimal code change in the editor.
3. Repeat!

NEXT: Refactoring to Use a Template

What we want to do is make our view function return exactly the same HTML, but just using a different process.

That's a **refactor**—when we try to improve the code without changing its functionality.