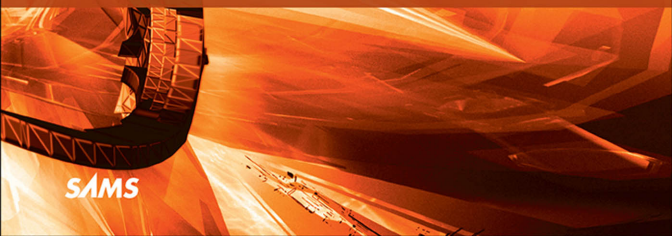
Andrew Pinkham

Django

UNLEASHED



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Django Unleashed

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Django Unleashed

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Django Unleashed

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Preface

In early 2013, a startup in Austin, Texas, approached me to work on a banking application using Django. My experience with Django was limited: I had tried to use the tool in 2009 but felt that the learning curve was steep. I wanted to give Django a try but did not have enough time to learn how to use it given the project's time constraints (which was fine: we were forced to use PHP anyway). When I looked at Django again in 2013, I discovered that it had become far more accessible. For certain, those four years had seen Django improve by leaps and bounds. However, I had also gained key knowledge working with web frameworks.

At the end of the project in 2013, I was asked by a different group to take what I had learned and teach its engineers how to program Django. I liked the work enough that I started creating a series of videos based on the material. During a test showing of the videos, one of my reviewers casually commented that the material would be more suitable and more approachable as a book. I still have a hard time believing that such an innocent comment resulted in a year and a half of such intense work, but that is the origin of this book: an off-hand comment.

This book is the book I wish I'd had in 2009 and in 2013. It is a how-to book that teaches you how to build a webpage from scratch using Django. The first part of the book (the first 12 chapters) are for my 2009 self. It answers the basic questions that I had when I started learning Django, and it explains the basics of web frameworks and websites. I think of the remaining chapters as a response to my 2013 self. They address the needs of more experienced users. Related materials are available at `https://django-unleashed.com`. I hope you find this book useful.

Is This Book for Me?

This book is meant for two types of people:

1. Programmers who have never built a website before and do not know how web frameworks operate
2. Programmers who have dabbled or used the basics of Django, and who would like to hone their skills and take advantage of Django's intermediate features

The book thus caters to both beginners and intermediate users. The only knowledge assumed is basic programming knowledge and Python.

What This Book Contains

This book is a hands-on, single example: we build and deploy a fully functional website over the course of the 30 chapters. Each chapter covers a single part of Django and is the logical next step to building our website while learning how to use Django.

Part I, Django's Core Features, is an introduction to websites, web frameworks, and Django. We assume knowledge of programming and Python, but absolutely no knowledge of the internals of back-end web programming. In these first 12 chapters, we use the core parts of Django—the parts used in (almost) every website—to create the basics of our website. This includes interacting with a database, sending HTML to visitors, and accepting user input in a safe manner.

Part II, Django's Contributed Library, examines the tools provided by Django that are helpful when building a website but that are not necessary to every site. Effectively, we will be adding features to our website to modernize the site and make it full-featured. From Chapter 13 through Chapter 23, we will see how to integrate CSS into our website, shorten our code through generic behavior, and add user authentication to our website.

Part III, Advanced Core Features, expands on Django's basics, detailing how to improve their use. We see how to take full control of our site, shortening code, optimizing our site for speed, and expanding behavior. We then deploy our website to the Internet, hosting the website on Heroku's managed cloud. Finally, in Chapter 30, we consider what we would have done differently in our project had we known at the beginning what we now know at the end of the book.

Conventions Used in This Book

This book is written with a bottom-to-top approach, meaning we start with a lower level of abstraction (more details) and gradually move up the abstraction ladder (shorter but more opaque code). If you would prefer to learn with a top-to-bottom approach, I recommend reading Chapter 12 after Chapter 1, and starting each chapter with the last section of the chapter, titled "Putting It All Together" throughout the book.

This book features quite a few asides (sometimes called admonitions) meant to help you understand Django or else to add tidbits of information to your programming toolkit.

Info An aside with basic information that extends or adds to the current content.

Warning! Gotchas, errors, and things to watch out for: these warnings are here to make your life easier by helping you avoid common mistakes.

Documentation Links to documentation from Django, Python, and other resources, which enable you to continue to learn material on the subject at hand.

Code Repository This book is heavily tied to the website found at `https://django-unleashed.com`, as is the project code found throughout the book and provided in full on github. Each example from the project has the git commit hash printed with it (and is a link to the digital version), allowing you to access each commit by adding `https://dju.link/` before the commit hash (this may in turn be followed by a file path). Even so,

every so often a particular commit is worth noting, and these asides will point you toward the code in the repository.

Ghosts of Django Past and Future The project in this book uses Django 1.8, the latest version, to create a website. However, it is not uncommon to find earlier versions of Django in the wild or at your new workplace. These asides aim to give you knowledge of changes between Django 1.4 and Django 1.8 so you can more easily navigate the various versions of Django if need be (that said, any new project should strive to use the latest version of Python and Django).

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Acknowledgments

I have been blessed with an incredible family. I could not have done this without them.

A huge thank you to Amber Gode and Anna Ossowski, both of whom read and reviewed large portions of this book and without whom this would be a very different product. Thanks to Wendell Smith, James Oakley, Dave Liechty, Jacinda Shelly, and Andrew Farrell for all of their hard work and feedback on both the code and the writing. Special thanks to Amy Bekkerman for always knowing the right question to ask. Thanks to Harry Percival for catching problems with the code. Thanks to Sasha Méndez for her feedback and particularly to Debra Williams Cauley of Pearson. She shared my enthusiasm for this project and enabled me to get this book going. Thank you to Sarah Abraham, Matt Kaemmerer, and Blake West, who were my very first guinea pigs (in the class that eventually gave rise to this book). Thanks to Paul Phillips for always grabbing a beer and listening to me complain about the sometimes frustrating, blinding work of coding and writing.

Finally, I want to acknowledge the Django and Python Communities. They are an amazing group of individuals, and I would not have written such an extensive book without their openness and support.

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About the Author

Andrew Pinkham is a software engineer who grew up in Paris and currently resides in Austin, Texas. Andrew runs a consulting business called JamBon Software, which specializes in web and mobile products and also offers Python and Django training. He prides himself on being an engineer who can communicate complex ideas in simple ways and is passionate about security and distributed systems. In his free time, Andrew writes fiction and swims. He is a 2009 graduate of Dartmouth College and can be found online at andrewsforge.com, or afrg.co for short.

We Want to Hear from You!

As the reader of this book, *you* are our most important critic and commentator. We value your opinion and want to know what we're doing right, what we could do better, what areas you'd like to see us publish in, and any other words of wisdom you're willing to pass our way.

We welcome your comments. You can email or write to let us know what you did or didn't like about this book—as well as what we can do to make our books better.

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1

Starting a New Django Project: Building a Startup Categorizer with Blog

In This Chapter

- The difference between static and dynamic websites
- The difference between the front end and back end of websites
- The HTTP request/response cycle
- The nature of a framework and how it differs from a library
- What it means to be a Python web framework (e.g., Django)
- The outline of the project we will build in Parts I, II, and III

1.1 Introduction

We have a lot to do and a lot to learn, but instead of jumping right in, let's take a moment to understand what we're doing.

Part I is an example meant to demonstrate the core features of Django. Part I is intended to be read linearly. Jump between chapters at your own peril!

This first chapter is a general introduction to the modern world of building dynamic websites. We start by introducing web technologies and jargon before taking a look at Django. Our introduction to Django focuses on what Django is and appropriate ways to use it. We then outline the project we'll build, scoping out the content for not only Part I but also Parts II and III. This overview gives us the opportunity to use Django to generate a basic project that we'll use throughout the book.

> **Warning!**
>
> This book assumes knowledge of Python (but not web technologies)! While the appendix supplies a very short review of Python, this book will not teach you to code in Python.

Info

This book is heavily tied to a git repository, which contains all of the project code and much of the example code found in this book:

https://github.com/jambonrose/DjangoUnleashed-1.8/

If you are reading the digital version of this book, the file paths and commit hashes in the project examples of this book are actually links that will take you directly to relevant commit on Github.

If you are reading a physical copy of this book, I have provided the `dju.link` shortlink domain. The link http://dju.link/9937ef66c0 will redirect you to the Github commit diff for the project, just as http://dju.link/9937ef66c0/helloworld/views.py will redirect you to the `views.py` file as it exists in the `9937ef66c0` hash.

Additional content may be found on the book's website:

http://django-unleashed.com/

Info

To get started with this book, you only really need to have Python and Django installed. However, having tools like git, virtualenvwrapper, and pip will make your life significantly easier. For install instructions and the full list of tools helpful for building Django projects, please see Appendix G.

1.2 Website Basics

Before talking about how we build websites, it's important to understand what a website is and how it operates.

When we open our browser and enter a URL such as `http://google.com`, our computer uses HTTP (the scheme in the URL) to talk to the computer (or set of computers) found at the `google.com` domain. The goal of this computer is to give us information that we are asking for.

A **website** is a resource stored on a server. A **server** is simply a computer whose job is to provide a resource (a website in this case) or service and *serve* it to you. A website comprises one or more webpages. A **webpage** is a discrete entity that contains data. The core functionality of a website is to send these webpages to people who ask for them. To do this, we use a protocol (a means of communication) called Hyper Text Transfer Protocol (HTTP). Formally, a user's browser sends an **HTTP request** to a website. The website then sends an **HTTP response** containing a webpage. The process is illustrated in Figure 1.1.

Each webpage is uniquely identifiable, usually by using a Uniform Resource Locator (URL). A URL is a string with specific information, split according to the following (specified in RFC 3986):[1] `scheme://network_location/path?query#fragments`. For example, Figure 1.2 shows the breakdown for a real URL.

The network location, or authority, is typically either an IP address (such as `127.0.0.1`) or a domain name, as shown in Figure 1.2. The scheme tells the browser not only what to

1. https://dju.link/rfc3986

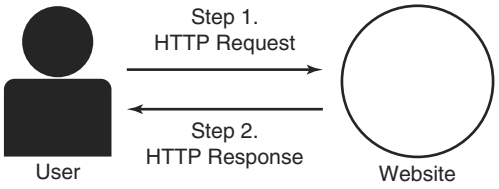

Figure 1.1: HTTP Request/Response Cycle Diagram

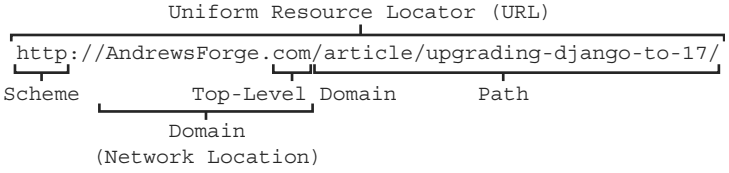

Figure 1.2: URL Components

get but how to get it. The URL `https://google.com/` tells the browser to use the HTTPS protocol (Secure HTTP) to go to the Google website and ask for the webpage found at `/` (the last slash on the URL is the path; if omitted, the slash is added implicitly).

In Part I, we only need to use scheme, network location, and path portions of our URLs. In Chapter 14: Pagination: A Tool for Navigation, we'll see how to make use of the query with Django. We won't make use of fragments, as they're typically used directly in HTML as anchors (links) internal to a single webpage.

The request/response loop of the HTTP protocol and the URL are the basis of *every* website. Originally, it was the only part of the website. Today, websites are more full-featured and more complex.

1.3 Understanding Modern Websites

HTTP is a stateless protocol: it doesn't know who you are or where you've been. It knows only what you've just asked it for. In the early days of the Internet, each webpage on a site was a file, such as a text file or a PDF. Websites were **static**.

Today, many websites are **dynamic**. We now interact with websites: instead of just asking the server to send us a file, we write comments on videos, blog about the best web framework ever, and tweet cat pictures to our friends. To enable these activities, webpages must be generated (computed) for each user based on new and changing data. We've had to add a number of technologies on top of HTTP to determine state (such as sessions, which we'll see in Chapter 19: Basic Authentication), and we now have entire languages and systems (like Django!) to make the dynamic generation of webpages as easy as possible. Our original HTTP loop now has an extra step between the request and response, as shown in Figure 1.3.

This dynamic generation of webpages is referred to as **back-end** programming, as opposed to **front-end** programming. Front-end programming involves creating the

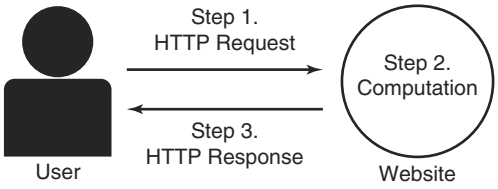

Figure 1.3: HTTP Request/Response Cycle Diagram

behavior of the webpage once it has already been generated by the back end. We can think of the combined experience in four steps:

1. A user's browser issues a request for a page.
2. The server (or back end) generates a markup file (typically HTML) based on recorded information and information provided by the user; this file in turn points the user to download associated content such as JavaScript, which defines behavior, and Cascading Style Sheets (CSS), which define style such as color and fonts. The entire set of items defines the webpage.
3. The server responds to the user's browser with this markup file (typically causing the browser to then ask for the other content such as CSS and JavaScript).
4. The user's browser uses the information to display the webpage. The combination of HTML (content and structure), CSS (style), and JavaScript (behavior) provides the front-end part of the website.

While front-end programming certainly provides for a dynamic experience, the words *dynamic webpage* typically refer to a webpage that is computed on the back end. It can be difficult to distinguish the difference between front-end and back-end programming because modern websites strive to blur the difference to create a more seamless user experience. In particular, websites known as **single-page applications** blur this line to the point that step 2 is seriously mangled. However, the distinction is still important, as the HTTP protocol remains between the user and the server and the tools for front-end and back-end programming are typically quite different.

Furthermore, this book does not cover front-end programming. We will see how to serve static content such as CSS and JavaScript in Chapter 16: Serving Static Content with Django, but we will not write a single line of either. This book is dedicated entirely to back-end programming and generating dynamic webpages with Django.

1.4 Building Modern Websites: The Problems That Frameworks Solve and Their Caveats

Very few people program dynamic websites from scratch anymore (i.e., without relying on other people's code). It is a difficult, tedious process, and it is typically not a good use of time. Instead, most developers rely on frameworks.

A framework is a large codebase, or collection of code, meant to provide universal, reusable behavior for a targeted project. For example, a mobile framework, such as those provided by Apple and Google for their mobile phones or smartphones, provides key functionality for building mobile apps. Consider the many touch actions on the iPhone: a user can tap his or her screen or hold, slide, turn with two fingers, and more. Developers do not need to worry about figuring out what touch action the user has performed: Apple's framework handles that task for developers.

Using frameworks offers enormous advantages. The most obvious is the removal of tedious and repetitive tasks: if iPhone apps require specific behavior, then the framework will provide it. This saves time for developers not only because of the provided functionality, which allows developers to avoid coding entirely, but also because the code provided is tested by many other developers on a wide variety of projects. This widespread testing is particularly important when it comes to security—a group of developers working on a framework are more likely to get sensitive components right than is any single developer.

Frameworks are different from other external codebases, such as libraries, because they feature **inversion of control**. Understanding inversion of control is key to properly using frameworks. Without a framework, the developer controls the flow of a program: he or she creates behavior or pulls behavior into the code project by calling functions from a library or toolkit. By contrast, when using a framework, the developer adds or extends code in specific locations to customize the framework to the program's requirements. The framework, which is essentially the base of the program, then calls those functions implemented by the developer. In this way, the framework, not the developer, dictates control flow. This is sometimes referred to as the Hollywood principle: "Don't call us, we'll call you." We can easily demonstrate the difference in pseudocode (Example 1.1).

Example 1.1: Python Code

```
# Using a Library
def my_function(*args):
    ...
    library.library_function(*args)
    ...

# Using a framework
def my_function(*args):
    ...

framework.run(my_function)
```

Inversion of control may seem counterintuitive or even impossible. How may the robot choose its behavior? Remember: the framework is built by other developers, and they are the ones who specify the behavior followed by the framework. As a developer using a framework, you are simply adding to or directing the behavior provided by other developers.

Using a framework has a few caveats. A framework may offer significant time savings, reusability, and security and may encourage a more maintainable and accessible codebase,

but only if the developer is knowledgeable about the framework. A developer cannot fill in all the gaps (by adding or extending code) expected by the framework until he or she understands where all the gaps are. Learning a framework can be tricky: because a framework is an interdependent system, using a part of the framework may require understanding another part of the system (we'll see this in Chapter 6: Integrating Models, Templates, Views and URL Configurations to Create Links between Webpages), which requires knowledge and tools from the three chapters preceding it. For this reason, using a framework requires investing significant overhead in learning the framework. In fact, it will take all of Part I of this book to explain the core inner workings of Django and to gain a holistic understanding of the framework. But once there, we'll be off to the races.

Despite this overhead, it is in your interest to use a framework and to spend the time to learn how to use it properly. Colloquially, developers are told, "Don't fight the framework."

1.5 Django: Python Web Framework

As outlined in Section 1.3, a website must always

1. Receive an HTTP request (the user asks for a webpage)
2. Process the request
3. Return the requested information as an HTTP response (the user sees the webpage)

Django is a free and open-source Python back-end web framework that removes the tedium of building websites by providing most of the required behavior. Django handles the majority of the HTTP request and response cycle (the rest is handled by the server Django runs on top of). Developers need only focus on processing the HTTP request, and Django provides tools to make even that easy.

All Django projects are organized in the same way, largely because of the framework's inversion of control but also because it makes navigating existing Django projects much easier for developers who, for instance, maintain the code or step into a job mid-project.

Django's project structure is most often described according to the Model-View-Controller (MVC) architecture because it makes the framework easier to learn. Originally, MVC was a very specific architecture, but it has become an umbrella term for libraries that are patterned after the following idea (illustrated in Figure 1.4):

- The Model controls the organization and storage of data and may also define data-specific behavior.
- The View controls how data is displayed and generates the output to be presented to the user.
- The Controller is the glue (or middleman) between the Model and View (and the User); the Controller will always determine what the user wants and return data to the user, but it may also optionally select the data to display from the Model or use the View to format the data.

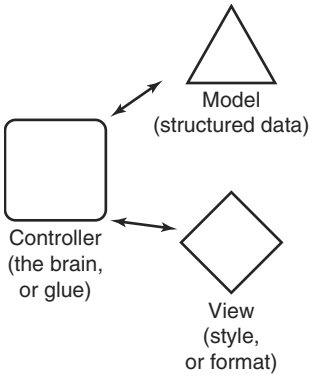

Figure 1.4: MVC Architecture Diagram

Most often, literature will state that different pieces of Django map to different pieces of MVC. Specifically,

- Django models are an implementation of MVC Models (Chapter 3: Programming Django Models and Creating a SQLite Database).
- Django templates map to MVC Views (Chapter 4: Rapidly Producing Flexible HTML with Django Templates).
- Django views and URL configuration are the two pieces that act as the MVC Controller (Chapter 5: Creating Webpages with Controllers in Django).

Warning!

Django and MVC use the word *view* to mean different things.

- The View portion of MVC determines how data is displayed.
- In Django, a view refers to something that builds a webpage and is part of the implementation of MVC Controllers.

Django views and MVC Views are unrelated. Do not confuse them.

The truth is a little bit more complicated. Django projects aren't truly MVC, especially if we abide by the original definition. We will discuss this topic in much more depth in Chapter 12: The Big Picture, once we have a better grasp of all of the moving pieces. For the moment, because it can help beginners organize the framework, we continue to use the (more modern and vague version of) MVC architecture to make sense of the framework.

If we combine our diagrams of the HTTP request/response loop and MVC architecture as in Figure 1.5, we get a much better picture of how Django works.

The Controller, the subject of Chapter 5, represents the heart of Django and is the only part of the MVC architecture that is necessary to generate a webpage. However, most

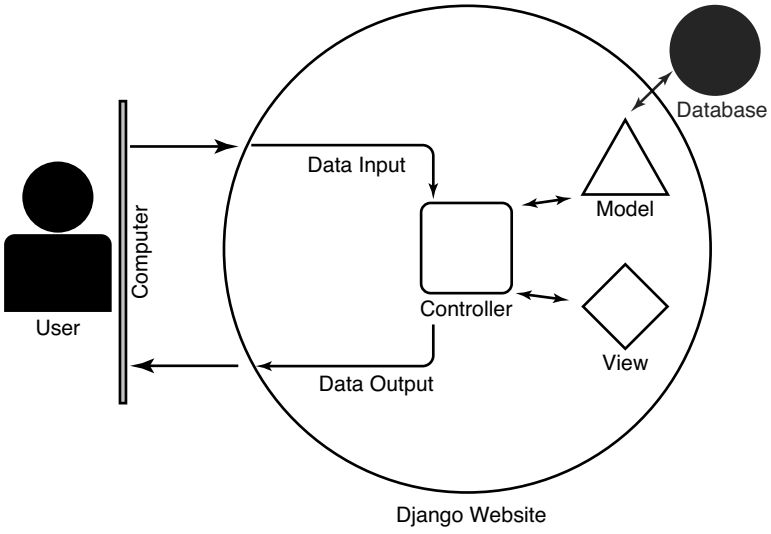

Figure 1.5: Application of MVC Architecture Diagram

browsers expect data to be returned by the server in specific formats, such as XML, HTML, or HTML5. The View encapsulates the tools Django supplies for easily outputting such data and is the subject of Chapter 4. Finally, we typically need to use persistent data when generating content in the Controller. The Model section represents the tools for structuring and storing data and is the subject of Chapter 3.

Info

You may have noticed that the popular format JSON is missing from the list of formats that the View section of Django outputs (XML, HTML, HTML5). Django doesn't need to supply a tool for outputting JSON because Python, which Django is built in, provides a JSON serializer.

You'll note that the Model section is connected to a database. The Model itself does not store data but instead provides tools for communicating with databases. We discuss the merits of databases in more depth in Chapter 3. For the moment, just note that Django provides the tools to communicate with several different databases, including SQLite, MySQL, PostgreSQL, and Oracle, which is yet another huge time-saver for us.

Django provides many more tools to make building websites easy. For instance, database schema migrations (Chapter 3 and Chapter 10: Revisiting Migrations), which help with managing models, and an authentication system (Chapter 19 and Chapter 22: Overriding Django's Authentication with a Custom User) are built in. What's more, Django is Python code, allowing developers to use any standard or third-party Python library. Python libraries afford developers an enormous amount of power and flexibility.

Django prides itself on being the "web framework for perfectionists with deadlines." Django provides the functionality needed for every website. The framework also comes with tools to make common website features easy to implement. This "batteries included" approach is why tens of thousands of developers use Django. Released into the wild in 2005, Django powers many websites, including Instagram, Pinterest, Disqus, and even *The Onion*. The core team of Django developers rigorously and regularly test Django, making it both fast and safe.

Django follows the Don't Repeat Yourself (DRY) principle. You will never need to repeat your code if you don't want to (of course, Django won't stop you if you do). Additionally, Django adheres to the Python philosophy that explicit is better than implicit. Django will never assume what you want and will never hide anything from you. If there is a problem, Django will tell you.

As mentioned in Section 1.3, despite all of the things Django will do for you, it will not build or help build front-end behavior for you (this is the purview of JavaScript apps and the browser). Django is a back-end framework, only one half of the equation for building a modern website. It allows you to dynamically create HTML for the front end (Chapter 4) and to intelligently provide the content necessary for a modern front end (Chapter 16), but it does not provide the tools to build dynamic browser behavior for the user. However, before you toss this book in a corner and walk away from Django forever, note that *a back end is necessary before a front end can exist*. A back end may be only half of the equation, but it is the first half: without the request/response loop, there is no website.

1.6 Defining the Project in Part I

The purpose of *Django Unleashed* is to teach Django by example. The goal of Part I of this book is to teach you the core fundamentals of Django, the parts of the system required by every website, and how MVC (mostly) applies to that system. To accomplish these tasks, we begin building a website that is self-contained to Django: we purposefully avoid any external libraries built for Django in order to better focus on the framework itself. At each step of the building process, you are introduced to a new Django feature, providing insight into the framework. By the end of Part I, these insights will allow you to see exactly how Django operates and adheres to MVC. Note that the book builds on this project all the way through Part III. Even then, the goal is not to build a production-quality website but rather to teach you via example. We nonetheless discuss how to begin and build a production website in Chapter 30.

1.6.1 Selecting Django and Python Versions

Django 1.8 is the latest and greatest Django version and is what every new project should use. Although this book includes informative notes about older versions, please do not use deprecated versions for new projects because these versions do not receive security updates.

Django 1.8 supports Python 2.7 and Python 3.2+ (Python 3.2, Python 3.3, and Python 3.4). When starting a new project, developers are left with the choice of which Python version to use for their project. The choice, unfortunately, is not as simple as picking the latest version.

Python 3 is the future, as Python 2.7 is officially the last Python 2 version. For a website to work for as long as possible, it becomes desirable to create Django websites in Python 3. However, Python 2 is still commonly used, as Django has only officially supported Python 3 since version 1.6, released in November 2013. What's more, enterprise Linux systems still ship with Python 2 as the default, and tools and libraries built for Django may still require Python 2 (as our site in Parts I, II, III is self-contained to Django, we do not need to worry about this decision yet, but we return to the issue in Chapter 30).

When creating reusable tools for a Django project, the gold standard is thus to write code that works in both Python 3 and Python 2. The easiest way to do this is to write code intended for Python 3 and then make it backward compatible with Python 2.7.

Our project is a simple website not aimed at being reused. In light of this and the many guides written about writing Python code that runs in both 2 and 3, our project will be built to run only in Python 3. Specifically, we use Python 3.4 (there is no technological reason to choose 3.2 or 3.3 over 3.4). This will further allow us to focus on Django itself and not get distracted by compatibility issues.

1.6.2 Project Specifications

Website tutorials have gone through phases. Tutorials started by teaching developers how to build blogs. Some disparaged these yet-another-blog tutorials as being passé. Writers switched first to building forums, then polls, and finally to-do lists.

In the real world, if you needed any of these applications, you would download an existing project such as WordPress or sign up for a service such as Medium. Rather than weeks of development, you would have a website by the end of an afternoon. It might not be as you envisioned your perfect site, but it would be good enough.

One of Django's major strengths is its precision. Django allows for the rapid creation of unusual websites that work exactly as the developer desires. It is in your interest for this book to build a website that is not available on the Internet already. The difficulty with building an unusual website is that the material tends to be less accessible.

Given the approachable nature of a blog, we will build a blog with special features. A blog is a list of articles, or **blog posts**, published on a single site and organized by date. Blog authors may choose to write about anything in each post, but they usually stick to a general theme throughout the entire blog. Our blog focuses on news relating to technology startup businesses. The goal is to help publicize startups to blog readers.

The problem with most blogs is that their topics are not well organized. Blogging platforms typically label blog posts with tags, leading writers to create tags for each item they blog about. A blog about startups would likely have a tag for each startup written about. We use Django to improve our blog's topic organization.

In our website, we expand blog functionality by codifying the creation of startups. Each startup will be its own object, not a tag. The advantage of making startups their own objects is that it allows us to add special information about them. We can now display information related to the business. We can list a description and a date, and we can even link to external articles written about the startup. These capabilities would not be possible if the startup were simply a tag.

Furthermore, we may organize startups with the same tags we use to label the blog posts. For example, we may label Startup A with the Mobile and Video Games tags. We could then tag Startup B with Mobile and Enterprise. These categories make organizing data simple but flexible. If we browse to the Mobile tag, the website uses that tag to list both Startup A and Startup B as well as any blog posts with the tag. For our website, we also enable blog posts to be directly connected to startup objects. Blog posts will thus exist for news about the site itself or to announce news about startups in our system. Our website makes startups far more discoverable than a regular blog website would.

In Part I, we focus on the most basic features. We create the blog, startup, and tagging system in Django. The goal is to make Django's core, features necessary to every website, as evident as possible.

In Part II, we allow authenticated users to log in. The public will be able to read any of the content of the website. Authenticated users will be able to submit articles, startups, and tags. These content suggestions will be reviewable by you, the site administrator.

In Part III, we allow for tag inheritance. If we write a blog post about Startup A, the tags labeling the startup will now also label the blog post.

It benefits us to list the webpages we will build in Part I:

1. A page to list tags
2. A page to list startups
3. A page to list blog posts
4. A page for each tag
5. A page for each startup
6. A page for each blog post (which also lists news articles)
7. A page to add a new tag
8. A page to add a new startup
9. A page to add a new blog post
10. A page to add and connect news articles to blog posts

1.7 Creating a New Django Project and Django Apps

In the following section, we create a new Django project in preparation for the website laid out in the last section. We then create Django apps, which are like small libraries within our project (we go over them in detail when we create them). By the end, we will be ready to start coding our website.

We do not cover how to install Django here. The official website has an excellent and updated guide[2] to do this. Just in case, however, I have supplied my own writing on the subject in Appendix G.

2. https://dju.link/18/install

1.7.1 Generating the Project Structure

Inversion of control means that Django already provides most of the code required to run a website. Developers are expected to supplement or extend the existing code so that the framework may then call this code; by placing code in key places, developers instruct the framework how to behave according to the developers' desires. Think of it as creating a building: even though many of the tools and contractors are supplied, the developer must still give these contractors orders, and the process requires a very specific scaffolding. Originally, building the scaffolding was a real pain, as developers had to manually account for framework conventions. Luckily, modern frameworks supply tools that generate the correct scaffolding for us. Once this scaffolding is in place, we can instruct the various contractors to behave in specific ways.

With Django correctly installed (please see Appendix G), developers have access to the `django-admin` command-line tool. This command, an alias to the `django-admin.py` script, provides subcommands to automate Django behavior.

> **Ghosts of Django Past**
>
> If you are using a version of Django prior to 1.7, then the alias `django-admin` will be unavailable. You will instead have to invoke the actual script, `django-admin.py`.

Our immediate interest with `django-admin` is the `startproject` subcommand, which automatically generates correct project scaffolding with many, but not all, of the expected Django conventions. To create a project named **suorganizer** (**s**tart **u**p **organizer**), you can invoke the command shown in Example 1.2.

Example 1.2: Shell Code

```
$ django-admin startproject suorganizer
```

Inside the new folder by the name of our new project, you will find the folder structure shown in Example 1.3.

Example 1.3: Shell Code

```
$ tree .
.
├── manage.py
└── suorganizer
    ├── __init__.pyr
    ├── settings.py
    ├── urls.py
    └── wsgi.py

1 directory, 5 files
```

Please note the existence of two directories titled `suorganizer`. To avoid confusion between the two directories, I distinguish the top one as root, or `/`, throughout the rest of the book. As such, instead of writing `suorganizer/manage.py`, I will refer to that file by writing `/manage.py`. Importantly, this means `/suorganizer/settings.py` refers to `suorganizer/suorganizer/settings.py`. What's more, all commands executed from the command line will henceforth be run from the root project directory, shown in Example 1.4.

Example 1.4: Shell Code

```
$ ls
manage.py   suorganizer
```

Let's take a look at what each file or directory does.

- `/` houses the entire Django project.
- `/manage.py` is a script much like `django-admin.py`: it provides utility functions. We will use it in a moment. Note that it is possible to extend `manage.py` to perform customized tasks, as we will see in Part II.
- `/suorganizer/` contains project-wide settings and configuration files.
- `/suorganizer/__init__.py` is a Python convention: it tells Python to treat the contents of this directory (`/suorganizer/`) as a package.
- `/suorganizer/settings.py` contains all of your site settings, including but not limited to
  - timezone
  - database configuration
  - key for cryptographic hashing
  - locations of various files (templates, media, static files, etc)
- `/suorganizer/urls.py` contains a list of valid URLs for the site, which tells your site how to handle each one. We will see these in detail in Chapter 5.
- `/suorganizer/wsgi.py` stands for Web Server Gateway Interface and contains Django's development server, which we see next.

1.7.2 Checking Our Installation by Invoking Django's `runserver` via `manage.py`

While Django has only created a skeleton project, it has created a *working* skeleton project, which we can view using Django's testing server (the one referenced in `/suorganizer/wsgi.py`). Django's `/manage.py` script, provided to every project, allows us to quickly get up to speed.

Django requires a database before it can run. We can create a database with the (somewhat cryptic) command `migrate` (Example 1.5).

Example 1.5: Shell Code

```
$ ./manage.py migrate
```

You should be greeted with the output (or similar output) shown in Example 1.6.

Example 1.6: Shell Code

```
Operations to perform:
  Synchronize unmigrated apps: staticfiles, messages
  Apply all migrations: contenttypes, auth, admin, sessions
Synchronizing apps without migrations:
  Creating tables...
    Running deferred SQL...
  Installing custom SQL...
Running migrations:
  Rendering model states... DONE
  Applying contenttypes.0001_initial... OK
  Applying auth.0001_initial... OK
  Applying admin.0001_initial... OK
  Applying contenttypes.0002_remove_content_type_name... OK
  Applying auth.0002_alter_permission_name_max_length... OK
  Applying auth.0003_alter_user_email_max_length... OK
  Applying auth.0004_alter_user_username_opts... OK
  Applying auth.0005_alter_user_last_login_null... OK
  Applying auth.0006_require_contenttypes_0002... OK
  Applying sessions.0001_initial... OK
```

We'll see exactly what's going on here starting in Chapter 3 and in detail in Chapter 10. For the moment, let's just get the server running by invoking the `runserver` command shown in Example 1.7.

Example 1.7: Shell Code

```
$ ./manage.py runserver
Performing system checks...

System check identified no issues (0 silenced).
May 2, 2015 - 16:15:59
Django version 1.8.1, using settings 'suorganizer.settings'
Starting development server at http://127.0.0.1:8000/
Quit the server with CONTROL-C.
```

Ghosts of Django Past

In versions prior to Django 1.7, the command above will not work, as `manage.py` does not have execute permissions. Run `chmod +x manage.py` to give `manage.py` the needed permission, or else execute it by invoking it through Python. For example: `python manage.py runserver`

If you navigate your browser to `http://127.0.0.1:8000/`, you should be greeted with the screen printed in Figure 1.6.

Django is running a test server on our new project. As the project has nothing in it, Django informs us we need to create an app using `/manage.py`.

To quit the server, type `Control-C` in the terminal.

1.7.3 Creating New Django Apps with `manage.py`

In Django nomenclature, a project is made of any number of apps. More expressly, a project is a website, while an app is a feature, a piece of website functionality. An app may be a blog, comments, or even just a contact form. All of these are encapsulated by a project, however, which is the site in its totality. An app may also be thought of as a library within the project. From Python's perspective, an app is simply a package (Python files can be modules, and a directory of modules is a package).

We have two features in our site: (1) a structured organization of startups according to tags and (2) a blog. We will create an app for each feature.

As with a project, Django supplies a way to easily create the scaffolding necessary to build an app. This time, we invoke `/manage.py` to do the work for us, although we could just as easily have used `django-admin`. Let's start with the central focus of our site, our startup organizer, and create an app called **organizer**, as shown in Example 1.8.

Figure 1.6: Runserver Congratulations Screenshot

Example 1.8: Shell Code

```
$ ./manage.py startapp organizer
```

The directory structure of the project should now be as shown in Example 1.9.

Example 1.9: Shell Code

```
$ tree .
.
├── manage.py
├── organizer
│   ├── __init__.py
│   ├── admin.py
│   ├── migrations
│   │   └── __init__.py
│   ├── models.py
│   ├── tests.py
│   └── views.py
└── suorganizer
    ├── __init__.py
    ├── settings.py
    ├── urls.py
    └── wsgi.py

3 directories, 11 files
```

Ghosts of Django Past

Prior to version 1.7, Django did not supply a migration system, and thus the `migrations` directory in projects older than that version will not appear, or will actually belong to a tool called South. Be careful about this when using projects built in early Django versions!

Info

You will likely also find files ending in `.pyc`. These are compiled Python files and can be safely ignored. However, if you find them as distracting as I do, you can use the following shell command to remove them: `find . -name '*.pyc'-delete`. Python will re-create them the next time your run your site.

Let's take a look at the new items.

- `/organizer/` contains all the files related to our new **organizer** app. Any file necessary to running our blog will be in this directory.
- `/organizer/__init__.py` is a Python convention: just as for `/suorganizer/__init__.py`, this file tells Python to treat the contents of this directory (`/organizer/`) as a package.
- `/organizer/admin.py` contains the configuration necessary to connect our app to the Admin library supplied by Django. While Admin is a major Django feature, it is

not part of Django's core functionality, and we will wait until Part II to examine it, along with the rest of the Django Contributed Library (apps included with Django's default install). If you are very impatient, you should be able to jump to Chapter 23: The Admin Library as soon as you've finished reading Chapter 5.

- `/organizer/migrations/` is a directory that contains data pertaining to the database tables for our app. It enables Django to keep track of any structural changes the developer makes to the database as the project changes, allowing for multiple developers to easily change the database in unison. We will see basic use of this database table in Chapter 3 and revisit the topic in Chapter 10.
- `/organizer/migrations/__init__.py` marks the `migration` directory as a Python package.
- `/organizer/models.py` tells Django how to organize data for this app. We do see how this is done in the next chapter.
- `/organizer/tests.py` contains functions to unit test our app. Testing is a book unto itself (written by Harry Percival), and we do not cover that material.
- `/organizer/views.py` contains all of the functions that Django will use to process data and to select data for display. We make use of views starting in Chapter 2 but won't fully understand them until Chapter 5.

Django encapsulates data and behavior by app. The files above are where Django will look for data structure, website behavior, and even testing. This may not make sense yet, but it means that when building a site with Django, it is important to consider how behavior is organized across apps. Planning how your apps interact and which apps you need, as we did earlier in this chapter, is a crucial step to building a Django site.

We can create our **blog** app in exactly the same way as the **organizer** app, as shown in Example 1.10.

Example 1.10: Shell Code

```
$ ./manage.py startapp blog
```

Note that the directory structure and all the files generated are exactly the same as for our **organizer** app.

1.7.4 Connecting Our New Django Apps to Our Django Project in `settings.py`

Consider for a moment the difference between `/organizer/` (or `/blog/`) and `/suorganizer/`. Both encapsulate data, the former for our **organizer** (or **blog**) app and the second for our project-wide settings, a phrase that should mean more now that we know the difference between an app and a project (reminder: a project is made up of one or more apps).

We must now connect our new apps to our project; we must inform our project of the existence of **organizer** and **blog**. On line 33 of `/suorganizer/settings.py`, you will find a list of items titled `INSTALLED_APPS`. Currently enabled in our project are a list of

Django contributed apps (you can tell because these items all start with `django.contrib`), some of which we examine in Part II. We append the list with our new apps, as shown in Example 1.11.

Example 1.11: Project Code
`suorganizer/settings.py` **in** `ba014edf45`

```
33  INSTALLED_APPS = (
34      'django.contrib.admin',
35      'django.contrib.auth',
36      'django.contrib.contenttypes',
37      'django.contrib.sessions',
38      'django.contrib.messages',
39      'django.contrib.staticfiles',
40      'organizer',
41      'blog',
42  )
```

Info

While the order of `INSTALLED_APPS` typically does not matter, there are instances in which apps listed prior to others will be given precedence. We see an instance of this in Chapter 24.

Let's run our test server again (Example 1.12).

Example 1.12: Shell Code

```
$ ./manage.py runserver 7777
Performing system checks...

System check identified no issues (0 silenced).
February 10, 2015 - 19:09:25
Django version 1.8.3, using settings 'suorganizer.settings'
Starting development server at http://127.0.0.1:7777/
Quit the server with CONTROL-C.
```

Info

Note that this time, I've run the server with an extra parameter that specifies which port I want to run on. Instead of the default port `8000`, the server may now be accessed on port `7777` via URL `http://127.0.0.1:7777/`. By convention, `http://127.0.0.1` will always point to your own computer. Any port may be specified, but a port number below `1024` may require superuser privileges (which are typically attained via `sudo`). The ability to specify a port is useful when the `8000` port

> is already taken. For instance, you may be testing another Django website at the same time or have another program that defaults to `8000`. To make the server publicly available on port 80 (the standard port for HTTP; a very dangerous thing to do), you could use the command `sudo ./manage.py runserver 0.0.0.0:80`.

Navigating to the page in your browser, you should be greeted by exactly the same page in your browser, telling you once again to

1. Create a new App
2. Configure our site URLs

We have successfully done item 1 and will demonstrate item 2 in our Hello World example in the next chapter.

We will return to our main project in Chapter 3, where we organize our data and create a database. In Chapter 4, we create templates to display data. In Chapter 5, we build our URL configuration (expanding on item 2 above) and the rest of the MVC Controller. These activities will effectively reveal how Model-View-Controller theory maps to Django.

1.8 Putting It All Together

The chapter outlined the project to be built in Parts I, II, and III of the book and introduced Django.

Django is a Python web framework based on MVC architecture, which signifies that Django removes the tedium of building websites by supplying a universal, reusable codebase. This approach saves developers time in the long run but creates an overhead cost of having to learn the interdependent system. Like any framework, Django works on the principle of inversion of control, sometimes called the Hollywood principle ("Don't call us, we'll call you"), which explains why we write code in locations dictated by Django convention. Specifically, in keeping with MVC architecture, we know that we need only worry about the Models, Views, and Controllers and that Django will glue them together and handle everything else.

In this chapter, we used `django-admin` to generate the project scaffolding necessary for Django. This scaffolding allows us to add code in specific locations, according to inversion of control.

We not only generated a Django project but also created the apps necessary for any project: a project is a website, whereas an app is a feature, a piece of website functionality. The site we've set out to build is a startup categorization system paired with a blog. Given the two features, we created two apps using Django's `manage.py` tool. We then used this tool to run a test server, checking our work. The test server informed us that, now that we have our apps created and connected to our project via `settings.py`, we should configure our site URLs. We take a quick look at this in the next chapter, but we wait until Chapter 5 before we really get there.

This book seeks to teach Django by example. Part I teaches Django's core, or the pieces of the framework that are typically required for every project. Django organizes project data according to MVC theory. Chapters 3, 4, and 5 each demonstrate a core Django feature, each an aspect of MVC. In Chapter 3, we organize our data and create a database.

In Chapter 4, we create the display output for our data. In Chapter 5, we connect our data to our display, creating webpages by programming Django views, pointed to by URL configurations.

Before we jump into MVC, however, Chapter 2: Hello World: Building a Basic Webpage in Django illustrates a basic Django site, which sheds light on the power of MVC.

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5

Creating Webpages with Controllers in Django: Views and URL Configurations

In This Chapter

- Build webpages with views and URL patterns
- Learn the purpose behind views and URL configurations
- Build views using both Python functions and objects
- Learn the differences between function and class-based views
- Make programming quicker with Django shortcuts
- Connect URL configurations to encapsulate behavior by app
- Preview webpage redirection

5.1 Introduction

In Chapter 2: Hello World: Building a Basic Webpage in Django, we saw that the Controller is the only part of Django actually required to make a webpage (the relevant diagram is reprinted in Figure 5.1). However, we immediately ran into problems: we had no way to easily fetch and format data. Because the main function of websites revolves around data, the Controller is often described as the glue between Model and View despite the Controller's independence.

In this chapter, we return to the Controller, seen earlier in Chapter 2 and Chapter 4: Rapidly Producing Flexible HTML with Django Templates. We first re-examine how the two parts of the Controller, URL configurations and views, interact. We then use the cumulative knowledge we have gained to build dynamic webpages.

The Controller is central to Django and comes with a number of options. Once we have the basics, we look at how to handle problems that occur in views. We then look at ways to more rapidly code views (at the cost of developer control). Coding views enable us to very quickly build all the webpages for our site.

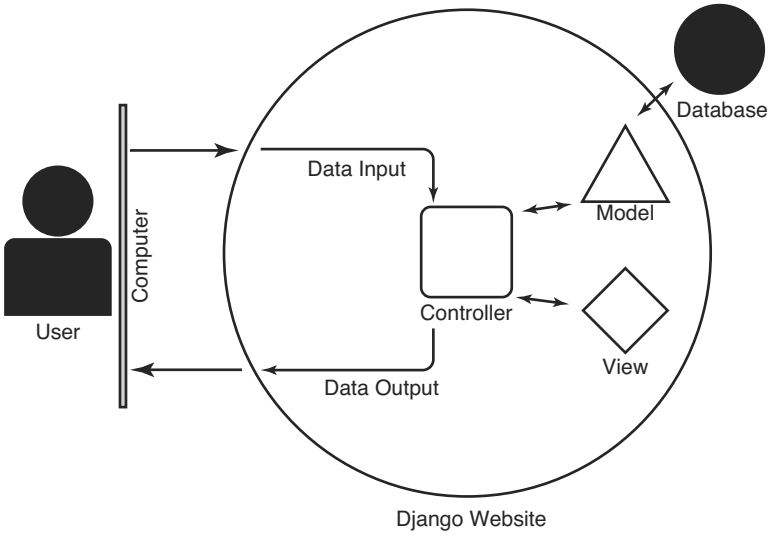

Figure 5.1: Application of MVC Architecture Diagram

Before we finish the chapter, we also examine two special methods for creating Controllers, which become important later in the book.

This chapter assumes knowledge of HTTP and regular expressions. Primers on both are provided in Appendix A and Appendix E, respectively.

5.2 The Purpose of Views and URL Configurations

A webpage consists of (1) the data contained in the webpage and (2) the URL (location) of the webpage. Django follows this abstraction by splitting the Controller into two parts. Django views give Django the data of the webpage. The URL associated with each view is listed in the URL configuration.

> **Warning!**
>
> For many beginners, the name of the Controller causes confusion: Django views are **unrelated** to MVC architecture's View. Django views are one half of the Controller. Django templates map to MVC's Views. To differentiate between the two, I capitalize *View* when referring to MVC and use lowercase *view* when referring to Django.

In the rest of this section, we expand on the nature and purpose of the URL configuration and views. To make the material more tangible, we then step through what happens when Django receives a request, detailing the actions the Controller takes.

5.2.1 Django URL Configurations

As discussed in Chapter 1, Section 1.2, webpages were originally quite basic. The webpage's data were contained in a flat file (a text file, an HTML file, or a PDF file, for instance). The URL was literally the location of the file on the server. If a user directed his or her browser to `http://awebsite.com/project1/important.pdf`, the `awebsite.com` server would go to the `project1` directory and fetch the `important.pdf` file to give to the user's browser.

Because modern web frameworks generate webpages dynamically, URLs have ceased to be the actual path to the data. A URL is now an abstraction, and it represents the logical path to data. For instance, the path `/startup/jambon-software` obviously requests information about the JamBon Software startup, whereas the path `/blog/2013/1/django-training/` is clearly a request for a blog post about Django classes published in January 2013.

The name *Uniform Resource Locator* is thus not quite right anymore, as we are not actually requesting the location of the data. Instead, we are simply identifying it. Appropriately, URLs are a direct subset of Uniform Resource Identifiers (URIs), as illustrated in Figure 5.2.

While there is some confusion surrounding the difference between URLs and URIs, RFC 3986[1] is quite clear on the topic (effectively superseding RFC 3305)[2]:

> A URI can be further classified as a locator, a name, or both. The term "Uniform Resource Locator" (URL) refers to the subset of URIs that, in addition to identifying a resource, provides a means of locating the resource by describing its primary access mechanism (e.g., its network "location").

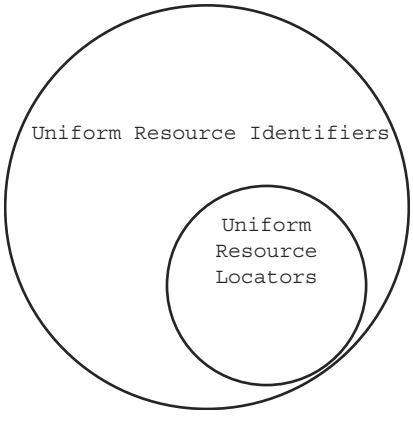

Figure 5.2: URLs are a subset of URIs

1. https://dju.link/rfc3986
2. https://dju.link/rfc3305

Every URL is thus a URI. However, a URL must specify a scheme to access the data, such as `http` or `https`, while a URI does not have to. According to this definition, the string `/blog/2013/1/django-training/` is a URI, but the string `http://site.django-unleashed.com/blog/2013/1/django-training/` is a URL despite the fact that the URL path is not an actual location. For this reason, Django continues to refer to URLs instead of URIs.

Because of the Hollywood principle (inversion of control), the URL configuration acts as a way to direct both users *and* Django to data. The URL configuration connects URLs to views: Django uses the URL configuration to find views. Django does not know the existence of any view without the URL configuration.

The URL configuration is a list of URL pattens. The URL pattern represents the two parts of a webpage: it maps a URI (the route/location/identifier) to a view (the data). Formally, the URI is a regular expression pattern, whereas the view is a Python callable. A URL configuration can also point to another URL configuration instead of a view, as we discuss in more depth in Section 5.7.1.

In Figure 5.3, each arrow is a URL pattern. Multiple URIs may point to a single view, but a single URI may not be defined more than once. The regular expression pattern in each URL pattern is how Django performs its matching. When Django receives an HTTP request, it tries to match the URL of the request to each and every regular expression pattern in each and every URL pattern. Upon finding a match, Django calls the view that the regular expression pattern maps to. Django uses the first match, meaning that the order of the list of URL patterns matters if there are several potential matches. If Django does not find a match, it returns an HTTP 404 error.

In the example provided by Figure 5.3, if a user requested the URI `/startup/`, perhaps in a URL such as `http://site.django-unleashed.com/startup/`, then Django

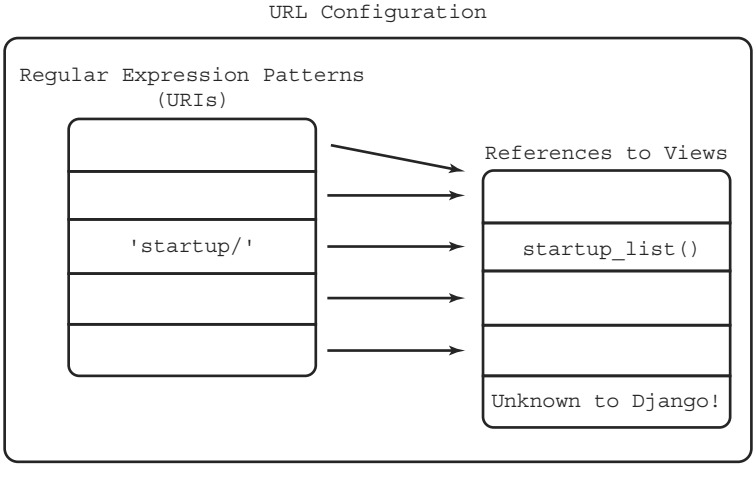

Figure 5.3: URL Configuration

would call the `startup_list()` function view. Django automatically strips the root slash of the URL path (to Django, `/startup/` becomes `startup/`).

We first coded a URL pattern in Chapter 2 and then again in Chapter 4. This last one, shown in Example 5.1, should still exist in `suorganizer/urls.py`.

Example 5.1: Project Code
`suorganizer/urls.py` **in** `95b20c151b`

```
23      url(r'^$', homepage),
```

Requesting the root path of our website causes Django to call `homepage()`, coded in `organizer/views.py`. We walk through exactly how Django does this shortly.

> **Info**
> A word of caution: there are *URL patterns*, and there are *regular expression patterns*. Simply referring to a pattern is ambiguous and should be avoided.

5.2.2 Django Views

The view is where webpage data is generated. The developer uses the view to interact with the database, load and render the template, and perform any other logic necessary to displaying a webpage.

A Django view is any Python callable (function, class, or object) that meets the following two requirements:

- Accepts an `HttpRequest` object as argument
- Returns an `HttpResponse` object

An `HttpRequest` object contains all of the information about the page requested, any data the user is passing to the website, and any data the browser is sending about the user. The `HttpResponse` returns an HTTP code (please see Appendix A for information about HTTP codes) as well as any data the developer chooses to return to the user.

Because the nature of a view depends solely on its input and output, any Python callable can be a view. Typically, however, you will be using either functions or Django's supplied classes to create views. For the moment, we build views using functions and wait until the end of the chapter to look at Django's class-based views.

Developers often refer to Django views as **view functions**. This is rather confusing, as views are not limited to being functions (this was not the case historically, which is where the vocabulary originates). In this book, I refer to any callable that builds a webpage as a **view**. Any view that is built using a function is called a **function view**, and any view that is an object is called a **class-based view** (following the documentation's nomenclature).

We currently have a function view coded in `organizer/views.py`, shown in Example 5.2.

Example 5.2: Project Code
`organizer/views.py` **in** `f0d1985791`

```
 7  def homepage(request):
 8      tag_list = Tag.objects.all()
 9      template = loader.get_template(
10          'organizer/tag_list.html')
11      context = Context({'tag_list': tag_list})
12      output = template.render(context)
13      return HttpResponse(output)
```

We can see how the function in Example 5.2 adheres to view requirements: it accepts an `HttpRequest` object as the `request` argument and returns an `HttpResponse` object with the output of a rendered template. It is also clearly dynamic, generating content based on data in the database.

In this chapter, we focus on using the database to generate dynamic pages. In Chapter 9: Controlling Forms in Views, we generate dynamic pages based on not only the database but also the contents of the `HttpRequest` object. In Chapter 15: Creating Webpages with Django Flatpages, we also discuss the ability to make static/flat pages with views.

5.3 Step-by-Step Examination of Django's Use of Views and URL Configurations

Nothing clarifies programming quite like walking through each step the code takes. Let's find out what happens when we run our web server and navigate to `http://127.0.0.1:8000/`.

Before we can go to the webpage, we have to start Django. We do so with Example 5.3.

Example 5.3: Shell Code

```
$ ./manage.py runserver
```

Django loads the settings in `suorganizer/settings.py`, configuring itself. It then loads all of the URL patterns in the URL configuration into memory, which allows Django to match URLs quickly. Once set up, we can type `http://127.0.0.1:8000/` into our browser.

Our browser begins by finding the server with the network location `127.0.0.1`. That's easy: that IP address always refers to the machine you're using. Once it knows that, it looks at the scheme and path of the URL and sends an HTTP request for the path `/` to itself on port 8000. Django receives this request.

> **Info**
> If we had requested just `http://127.0.0.1:8000` (without the last slash), the browser would still request the path `/`. It is implicit in this case.

Django first translates the actual HTTP request (raw data) into an `HttpRequest` object (Python). Having this object in Python makes it easy for us and the framework to manipulate any information the browser is passing our site, as we shall discover in Chapter 9. Django takes the path in the `HttpRequest` object—currently `/`—and strips it of the first `/`. In this case, we are left with the empty string. *Our new path is the empty string* `"`.

Django's next goal is to select a URL pattern. Django has the list of URL patterns in the URL configuration it loaded into memory when it first started up. Each URL pattern consists of at least two things: a regular expression pattern and a view. To select a URL pattern, Django tries to match the requested path—the empty string in this case—to each regular expression pattern of each URL pattern. Given our URL configuration, Django currently has only two options, shown in Example 5.4.

Example 5.4: Project Code

`suorganizer/urls.py` **in** `95b20c151b`

```
16  from django.conf.urls import include, url
17  from django.contrib import admin
18
19  from organizer.views import homepage
20
21  urlpatterns = [
22      url(r'^admin/', include(admin.site.urls)),
23      url(r'^$', homepage),
24  ]
```

Each call to `url()` in Example 5.4 is a URL pattern. Django tries to match the empty string, derived from the URL path, to each of the regular expression patterns in the URL patterns above. The empty string very clearly does not match the text `admin/`. However, Django will select the second URL pattern because the regular expression `r'^$'` matches the empty string:

- The `r` informs Python the string is raw, meaning it does not escape any of the characters in the string.
- The `^` matches the beginning of a string.
- The `$` matches the end of a string.

With the URL pattern `url(r'^$', homepage)` selected, Django calls the Python function the URL pattern points to. In this case, the URL pattern points to the `homepage()` Python function, imported via the call `from organizer.views import homepage` on line 19. When Django calls the view, it passes the `HttpRequest` object to the view.

We coded the view such that it loads tag data from the database, loads the tag list template, and renders the template with the `Tag` object data. We then pass this output to an `HttpResponse` object and return it to Django. Django translates this object into a real HTTP response and sends it back to our browser. Our browser then displays the webpage to us.

To clarify, the regular expression `r'^a$'` would match a request to `http://127.0.0.1:8000/a`. If we were to change the URL pattern from `url(r'^$', homepage)` to `url(r'^home/$', homepage)`, we would now need to navigate to `http://127.0.0.1:8000/home/` to run the `homepage()` function and display a list of tags.

Inversion of control should be apparent. We are not controlling Django. It translates HTTP requests and responses for us and handles the entire URL matching process. We are simply providing it with the data to use in these matches and telling it what to use to build the webpage (the view). And even then, we are relying heavily on the tools Django provides.

If we were to ask Django for a webpage that did not exist, such as `http://127.0.0.1:8000/nonexistent/`, Django would try to match `nonexistent/` to the regular expression patterns in our URL configuration. When it did not find one, it would error. In production, Django would send back an HTTP 404 response. However, because we have `DEBUG=TRUE` in our `suorganizer/settings.py` file, Django instead tries to warn us of the problem and shows us a list of valid URL paths.

5.4 Building Tag Detail Webpage

To reinforce what we already know and expand our knowledge of URL patterns, we now create a second webpage. Our webpage will display the information for a single `Tag` object. We call our function view `tag_detail()`. Let's begin by adding a URL pattern.

In Chapter 3, we specifically added `SlugField` to our `Tag` model to allow for the simple creation of unique URLs. We intend to use it now for our URL pattern. We want the request for `/tag/django/` to show the webpage for the *django* Tag and the request for `/tag/web/` to show the webpage for the *web* Tag.

This is the first gap in our knowledge. How can we get a single URL pattern to recognize both `/tag/django/` and `/tag/web/`? The second gap in our knowledge is that we have no easy way to use the information in the URL pattern. Once we've isolated *django* and *web*, how can we pass this information to the view so that it may request the data from the database?

To make the problem more concrete, let's start with the `tag_detail()` view.

5.4.1 Coding the `tag_detail()` Function View

Open `/organizer/views.py` and program the bare minimum functionality of a view (accept an `HttpRequest` object, return an `HttpResponse` object), as shown in Example 5.5.

Example 5.5: Project Code
`organizer/views.py` **in** `f0d1985791`

```
16  def tag_detail(request):
17      return HttpResponse()
```

Our first task is to select the data for the `Tag` object that the user has selected. For the moment, we will assume that we have somehow been passed the unique slug value of the `Tag` as the variable `slug`, and we use it in our code (but Python will yell at you if you try to run this). We use the `get()` method of our `Tag` model manager, which returns a single object. We want our search for the `slug` field to be case insensitive, so we use the `iexact` field lookup scheme. Our lookup is thus `Tag.objects.get(slug__iexact=slug)`, as shown in Example 5.6.

Example 5.6: Project Code
`organizer/views.py` **in** `ba4f692e00`

```
16  def tag_detail(request):
17      # slug = ?
18      tag = Tag.objects.get(slug__iexact=slug)
19      return HttpResponse()
```

We may now load the template we wish to render, `organizer/tag_detail.html`. When we wrote the template, we wrote it to use a variable named `tag`. We thus create a `Context` object to pass the value of our Python variable named `tag` to our template variable `tag`. Recall that the syntax is `Context({'template_variable_name': Python_variable_name})`. We thus extend our view code as shown in Example 5.7.

Example 5.7: Project Code
`organizer/views.py` **in** `2fdb78366f`

```
16  def tag_detail(request):
17      # slug = ?
18      tag = Tag.objects.get(slug__iexact=slug)
19      template = loader.get_template(
20          'organizer/tag_detail.html')
21      context = Context({'tag': tag})
22      return HttpResponse(template.render(context))
```

We have what would be a fully working function view if not for the problem we are now forced to confront: the `slug` variable is never set. The value of the slug will be in the URL path. If Django receives the request for `/tag/django/`, we want the value of our `slug` variable to be set to `'django'`. Django provides two ways to get it.

The first way is terrible and inadvisable: we can parse the URL path ourselves. The `request` variable, an `HttpRequest` object, contains all the information provided by the user and Django, and we could access `request.path_info` to get the full path. In our example above, `request.path_info` would return `'tag/django/'`. However, to get the slug from our URL path, we would need to parse the value of `request.path_info`, and doing so in each and every view would be tedious and repetitive, in direct violation of the Don't Repeat Yourself (DRY) principle.

The second method, the recommended and easy solution, is to get Django to send it to us via the URL configuration, as we shall discover in the next section. To accommodate this solution, we simply add `slug` as a parameter to the function view.

Our final view is shown in Example 5.8.

Example 5.8: Project Code
`organizer/views.py` **in** `84eb438c96`

```
16  def tag_detail(request, slug):
17      tag = Tag.objects.get(slug__iexact=slug)
18      template = loader.get_template(
19          'organizer/tag_detail.html')
20      context = Context({'tag': tag})
21      return HttpResponse(template.render(context))
```

5.4.2 Adding a URL Pattern for `tag_detail`

With our `tag_detail()` function view fully programmed, we now need to point Django to it by adding a URL pattern to the URL configuration. The pattern will be in the form of `url(<regular_expression>, tag_detail)`, where the value of `<regular_expression>` is currently unknown. In this section, we need to solve two problems:

1. We need to build a regular expression that allows for multiple inputs. For example, `/tag/django/` and `/tag/web/` must both be valid URL paths.
2. We must pass the value of the slug in the URL path to the detail view.

The answer to both of these problems is to use regular expressions groups.

To solve the first case, we first begin by building a static regular expression. Remember that our regular expressions patterns should not start with a `/`. To match `/tag/django/` we can use the regular expression `r'^tag/django/$'`. Similarly, `r'^tag/web/$'` will match `/tag/web/`. The goal is to build a regular expression that will match all slugs. As mentioned in Chapter 3, a `SlugField` accepts a string with a limited character set: alphanumeric characters, the underscore, and the dash. We first define a regular expression character set by replacing `django` and `web` with two brackets: `r'^tag/[]/$'`. Any character or character set inside the brackets is a valid character for the string. We want multiple characters, so we add the `+` character to match at least one character: `r'^tag/[]+/$'`. In Python, `\w` will match alphanumeric characters and the underscore. We can thus add `\w` and `-` (the dash character) to the character set to match a valid slug: `r'^tag/[\w\-]+/$'`. This regular expression will successfully match `/tag/django/`, `/tag/web/`, and even `/tag/video-games/` and `/tag/video_games/`.

> **Info**
> In the code above we opted to specify `[\w\-]+` for the slug match, instead of `[\w-]+` or `[-\w]+`. Python will accept and work correctly with `[\w-]+` or `[-\w]+`, but the

character set is imprecise. The - character is reserved for specifying ranges, such as [A-Z]+, which will match any capital alphabet character. To specify the - character, we have to escape it with a slash: the [A\-Z]+ pattern will match a string of any length than contains only the letters A, Z, or -. However, as you may have guessed, if the dash is specified at the the beginning or end of a character set, Python is smart enough to realize that you mean the character rather than a range. Even so, this can be ambiguous to other programmers, and it's best to always escape the dash when you want to match the - character.

This regular expression matches all of the URLs we actually want, but it will not pass the value of the slug to the tag_detail() function view. To do so, we can use a named group. Python regular expressions identify named groups with the text (?P<name>pattern), where name is the name of the group and pattern is the actual regular expression pattern. In a URL pattern, Django takes any named group and passes its value to the view the URL pattern points to. In our case, we want our named group to use the pattern we just built—[\w\-]+—and to be called slug. We thus have (?P<slug>[\w\-]+).

Our full regular expression has become r'^tag/(?P<slug>[\w\-]+)/$'. This regular expression will match a slug and pass its value to the view the URL pattern points to. We can now build our URL pattern.

We are building a URL pattern for our tag_detail() view, which exists in the views.py file in our **organizer** app. We first import the view via a Python import and then create a URL pattern by calling url() and passing the regular expression and the view. Example 5.9 shows the resulting URL configuration in suorganizer/urls.py.

Example 5.9: Project Code
suorganizer/urls.py **in** 5b18131069

```
16  from django.conf.urls import include, url
 .      ...
19  from organizer.views import homepage, tag_detail
 .      ...
24      url(r'^tag/(?P<slug>[\w\-]+)/$',
25          tag_detail,
26          ),
```

If we request http://127.0.0.1:8000/tag/django or the Django runserver, Django will select our new URL pattern and call tag_detail(request, slug='django').

The regular expression pattern and view pointer are not the only parameters we can pass to url(). It is possible, and highly recommended, to specify the keyword argument name for URL patterns. The utility of specifying name is the ability to refer to a URL pattern in Django, a practice we discuss in Chapter 6: Integrating Models, Templates, Views, and URL Configurations to Create Links between webpages. This practice not only is useful in Django but also allows me to refer to URL patterns in the book without ambiguity.

It is possible to name a URL pattern whatever you wish. However, I strongly recommend you namespace your names, allowing for easy reference without conflict across your site. In this book, I use the name of the app, the name of the model being used, and the display type for the object type. We thus name the URL pattern `organizer_tag_detail`. Our final URL pattern is shown in Example 5.10.

Example 5.10: Project Code
`suorganizer/urls.py` **in** `79c8d40d8a`

```
24      url(r'^tag/(?P<slug>[\w\-]+)/$',
25          tag_detail,
26          name='organizer_tag_detail'),
```

> **Info**
> When I refer to namespaces, I mean it in an informal sense: it's simply a string that we structure in a particular way. I am not referring to the actual URL namespace tool Django provides that we will use in Chapter 19: Basic Authentication.

Consider all the code we have avoided writing by writing our URL pattern intelligently. At the end of Section 5.4.1, we were considering parsing the raw URL path string (passed to the view via `request.path_info`) to find the slug value of our tag. Thanks to Django's smart URL configuration, simply by providing a named group to our regular expression pattern, we can pass values in the URL directly to the view.

5.5 Generating 404 Errors for Invalid Queries

As things stand, we can use the command line to start our development server (Example 5.11) and see the fruits of our labor.

Example 5.11: Shell Code

```
$ ./manage.py runserver
```

If you navigate to the address of a valid `Tag`, you will be greeted by a simple HTML page built from our template. For example, `http://127.0.0.1:8000/tag/django/` will display a simple page about our Django tag. However, what happens if you browse to a URL built with an invalid tag slug, such as `http://127.0.0.1:8000/tag/nonexistent/`?

You'll be greeted by a page of Django debug information, as shown in Figure 5.4.

Django is displaying a page informing you that Python has thrown an exception. The title of the page, "DoesNotExist at /tag/nonexistent/," tells us that the URL we asked for does not exist. The subtitle, "Tag matching query does not exist" tells us that the database query for our `Tag` could not find a row in the database that matched what we desired (in this case, we queried `Tag.objects.get(slug__iexact='nonexistent')`). What's

more, below the initial readout presented in Figure 5.4, you'll find a Python traceback, shown in Figure 5.5, where Django informs us that the Python exception type being raised is `DoesNotExist`.

Of the four functions in the traceback, three are in Django's source code and therefore (most likely) are not the problem. The second item in the traceback, however, is in `/organizer/views.py` and reveals that the code throwing the exception is `tag = Tag.objects.get(slug__iexact=slug)`, on line 17. This does not mean the code is wrong (it isn't!), simply that the problem originates there. The problem, as stated in the top half of the page, is that there is no `Tag` object with slug "nonexistent" in the database.

This message is obviously not what we want users to be greeted with in the event of a malformed URL. The standard return for such in websites is an HTTP 404 error. Let us

Figure 5.4: Django Error Message

Figure 5.5: Django Error Traceback

return to our function view in `/organizer/views.py` and augment it so that it returns a proper HTTP error rather than throwing a Python exception.

Django supplies two ways to create an HTTP 404 error. The first is with the `HttpReponseNotFound` class, and the second is with the `Http404` exception.

The `HttpReponseNotFound` class is a subclass of the `HttpResponse` class. Like its superclass, `HttpReponseNotFound` expects to be passed the HTML content it is asked to display. The key difference is that returning an `HttpResponse` object results in Django returning an HTTP 200 code (Resource Found), whereas returning a `HttpReponseNotFound` object results in an HTTP 404 code (Resource Not Found).

The `Http404` is an exception and as such is meant to be raised rather then returned. In contrast to the `HttpReponseNotFound` class, it does not expect any data to be passed, relying instead on the default 404 HTML page, which we build in Chapter 29: Deploy! when we deploy our site.

Consider that our code is currently raising a `DoesNotExist`. We therefore have to catch this exception and then proceed with an HTTP 404 error. It is thus more appropriate and more Pythonic to use an exception, meaning our code in Example 5.12 will use the `Http404` exception. Start by importing this in the file, by adding `Http404` to the second import line (the one for `HttpResponse`). The import code should now read as shown in Example 5.12.

Example 5.12: Project Code
`organizer/views.py` **in** `294dabd8cc`

```
1  from django.http.response import (
2      Http404, HttpResponse)
```

To catch the `DoesNotExist` exception, we surround our model manager query with a Python `try...except` block. Should the query raise a `DoesNotExist` exception for a `Tag` object, we then raise the newly imported `Http404`. This leaves us with the code shown in Example 5.13.

Example 5.13: Project Code
`organizer/views.py` **in** `294dabd8cc`

```
17  def tag_detail(request, slug):
18      try:
19          tag = Tag.objects.get(slug__iexact=slug)
20      except Tag.DoesNotExist:
21          raise Http404
22      template = loader.get_template(
23          'organizer/tag_detail.html')
24      context = Context({'tag': tag})
25      return HttpResponse(template.render(context))
```

Had we opted to use `HttpReponseNotFound`, we might have coded as in Example 5.14.

Example 5.14: Python Code

```
    # this code not optimal!
    try:
        tag = Tag.objects.get(slug__iexact=slug)
    except Tag.DoesNotExist:
        return HttpReponseNotFound('<h1>Tag not found!</h1>')
```

Raising an exception rather than returning a value is considered better Python practice because `raise()` was built explicitly for this purpose. What's more, it allows us to create a single 404.html page in Chapter 29, further maintaining the DRY principle.

Note that some developers might try to use the code shown in Example 5.15.

Example 5.15: Python Code

```
    # this code is incorrect!
    tag = Tag.objects.get(slug__iexact=slug)
    if not tag:
        return HttpReponseNotFound('<h1>Tag not found!</h1>')
```

The code is incorrect: it will not catch the `DoesNotExist` exception raised by the model manager query. A `try...except` block is required.

If you browse to `http://127.0.0.1:8000/tag/nonexistent` on the development server now, you will be treated to an HTTP 404 page, which is our desired behavior.

The error in this section is different from a nonmatching URL. If you browse to `http://127.0.0.1:8000/nopath/`, Django will tell you it couldn't match the URL to a URL pattern and, in production, will return a 404 error automatically. The issue we solved here was when the URL did match but the view did not behave as expected.

5.6 Shortening the Development Process with Django View Shortcuts

We now have a two-function view in `/organizer/views.py`, which currently reads as shown in Example 5.16.

Example 5.16: Project Code
`organizer/views.py` **in** `294dabd8cc`

```
1  from django.http.response import (
2      Http404, HttpResponse)
3  from django.template import Context, loader
```

```
 4
 5  from .models import Tag
 6
 7
 8  def homepage(request):
 9      tag_list = Tag.objects.all()
10      template = loader.get_template(
11          'organizer/tag_list.html')
12      context = Context({'tag_list': tag_list})
13      output = template.render(context)
14      return HttpResponse(output)
15
16
17  def tag_detail(request, slug):
18      try:
19          tag = Tag.objects.get(slug__iexact=slug)
20      except Tag.DoesNotExist:
21          raise Http404
22      template = loader.get_template(
23          'organizer/tag_detail.html')
24      context = Context({'tag': tag})
25      return HttpResponse(template.render(context))
```

That is a lot of code for two simple webpages. We also have a lot of duplicate code in each function, which is not in keeping with the DRY philosophy. Luckily for developers, Django provides shortcut functions to ease the development process and to significantly shorten code such as the preceding.

5.6.1 Shortening Code with `get_object_or_404()`

Our first shortcut, `get_object_or_404()`, is a complete replacement for the `try...except` block that currently exists in our `tag_detail()` function.

Let's start by importing it into our `/organizer/views.py` file, as in Example 5.17.

Example 5.17: Project Code
`organizer/views.py` **in** `5705e49877`

```
 2  from django.shortcuts import get_object_or_404
```

We can then delete the following lines, as in Example 5.18.

Example 5.18: Project Code
`organizer/views.py` **in** `294dabd8cc`

```
18      try:
19          tag = Tag.objects.get(slug__iexact=slug)
20      except Tag.DoesNotExist:
21          raise Http404
```

We replace the content in Example 5.18 with the code in Example 5.19.

Example 5.19: Project Code
`organizer/views.py` **in** `5705e49877`

```
18      tag = get_object_or_404(
19          Tag, slug__iexact=slug)
```

The `get_object_or_404()` shortcut expects to have the model class and the desired query passed as arguments and will return the object if it finds one. If not, it raises `Http404`, just as we had programmed before. Because we are passing in the `Tag` object and using exactly the same query, the behavior of our shortened code is exactly the same as that of our original code.

Our `tag_detail()` thus reads as in Example 5.20.

Example 5.20: Project Code
`organizer/views.py` **in** `5705e49877`

```
17  def tag_detail(request, slug):
18      tag = get_object_or_404(
19          Tag, slug__iexact=slug)
20      template = loader.get_template(
21          'organizer/tag_detail.html')
22      context = Context({'tag': tag})
23      return HttpResponse(template.render(context))
```

5.6.2 Shortening Code with `render_to_response()`

Most views must do the following:

1. Load a template file as a `Template` object.
2. Create a `Context` from a dictionary.
3. Render the `Template` with the `Context`.
4. Instantiate an `HttpResponse` object with the rendered result.

Django supplies not one but two shortcuts to perform this process for us. The first is the `render_to_response()` shortcut. The shortcut replaces the behavior that we currently have in our views, performing all four tasks listed above. Let's start by importing it, adding it to the end of our pre-existing shortcut import, as shown in Example 5.21.

Example 5.21: Project Code
`organizer/views.py` **in** `5ff3dee4fa`

```
1   from django.shortcuts import (
2       get_object_or_404, render_to_response)
```

We can now use `render_to_response()` to shorten our code. In our `homepage()` view, for instance, we can remove the code shown in Example 5.22.

Example 5.22: Project Code
`organizer/views.py` **in** `5705e49877`

```
 7  def homepage(request):
 8      tag_list = Tag.objects.all()
 9      template = loader.get_template(
10          'organizer/tag_list.html')
11      context = Context({'tag_list': tag_list})
12      output = template.render(context)
```

The code in Example 5.22 is easily replaced with the code in Example 5.23.

Example 5.23: Project Code
`organizer/views.py` **in** `5ff3dee4fa`

```
 7  def homepage(request):
 8      return render_to_response(
 9          'organizer/tag_list.html',
10          {'tag_list': Tag.objects.all()})
```

Observe how we pass in the same path to the template and a simple dictionary with the (identical) values to populate the template. The shortcut does the rest for us: the behaviors in the preceding two code examples are exactly the same.

The process to shorten `tag_detail()` is exactly the same. We start by removing the code in Example 5.24.

Example 5.24: Project Code
`organizer/views.py` **in** `5705e49877`

```
20      template = loader.get_template(
21          'organizer/tag_detail.html')
22      context = Context({'tag': tag})
23      return HttpResponse(template.render(context))
```

Then, in Example 5.25, we write a call to `render_to_response()`, passing in the same values seen in the previous code: the same template path and the same dictionary passed to our `Context` instantiation.

Example 5.25: Project Code
`organizer/views.py` **in** `5ff3dee4fa`

```
16      return render_to_response(
17          'organizer/tag_detail.html',
18          {'tag': tag})
```

Our entire file has been reduced to the code shown in Example 5.26.

Example 5.26: Project Code
`organizer/views.py` **in** `5ff3dee4fa`

```
 1  from django.shortcuts import (
 2      get_object_or_404, render_to_response)
 3
 4  from .models import Tag
 5
 6
 7  def homepage(request):
 8      return render_to_response(
 9          'organizer/tag_list.html',
10          {'tag_list': Tag.objects.all()})
11
12
13  def tag_detail(request, slug):
14      tag = get_object_or_404(
15          Tag, slug__iexact=slug)
16      return render_to_response(
17          'organizer/tag_detail.html',
18          {'tag': tag})
```

The code in Example 5.26 was the original way to shorten code and, while still frequently seen on the Internet and in older projects, is no longer the best way to shorten a simple view. Instead, you'll want to use `render()`.

5.6.3 Shortening Code with `render()`

Before introducing the `render_to_response()` shortcut, our `/organizer/views.py` read as shown in Example 5.27.

Example 5.27: Project Code
`organizer/views.py` **in** `4d36d603db`

```
1  from django.http.response import HttpResponse
2  from django.shortcuts import get_object_or_404
3  from django.template import Context, loader
```

```
 4
 5  from .models import Tag
 6
 7
 8  def homepage(request):
 9      tag_list = Tag.objects.all()
10      template = loader.get_template(
11          'organizer/tag_list.html')
12      context = Context({'tag_list': tag_list})
13      output = template.render(context)
14      return HttpResponse(output)
15
16
17  def tag_detail(request, slug):
18      tag = get_object_or_404(
19          Tag, slug__iexact=slug)
20      template = loader.get_template(
21          'organizer/tag_detail.html')
22      context = Context({'tag': tag})
23      return HttpResponse(template.render(context))
```

Example 5.27 is sufficient for the simple views we are currently building but will prove to be inadequate in the long run. Specifically, we are not using Django context processors.

At the moment, our views are rendering `Template` instances with `Context` instances and passing the result to an `HttpResponse` object. The problem with this approach is that sometimes Django needs to make changes to the values within the `Context` objects. To enable Django to make changes to data that render a `Template`, we must use a `RequestContext` instead of a `Context` object. When a `Template` renders with a `RequestContext`, Django uses the `HttpRequest` object to add data to the `RequestContext`, providing information not available to `Context`. To do so, Django calls the context processors, which are simply functions that are listed in the `TEMPLATES` options of `/suorganizer/settings.py` (Example 5.28).

Example 5.28: Project Code
`suorganizer/settings.py` **in** `4d36d603db`

```
58  TEMPLATES = [{
 .      ...
64      'OPTIONS': {
65          'context_processors': [
66              'django.template.context_processors.debug',
67              'django.template.context_processors.request',
68              'django.contrib.auth.context_processors.auth',
69              'django.contrib.messages.context_processors.messages',
70          ],
71      },
72  }]
```

At the moment, enabling context processors is of no use to us, but in Chapter 9, we build views and templates that rely on Django context processors. However, it behooves us to examine them now, as they provide insight into our new shortcut.

To make the change to using context processors, we need only change each use of `Context` to `RequestContext`. The only difference is that `RequestContext` needs the `HttpRequest` object, as it intends to pass it to all the context processors. We therefore pass `request` to `RequestContext` before the dictionary of values. Our code now reads as shown in Example 5.29.

Example 5.29: Project Code

`organizer/views.py` **in** `c392ab707a`

```
from django.http.response import HttpResponse
from django.shortcuts import get_object_or_404
from django.template import RequestContext, loader

from .models import Tag


def homepage(request):
    tag_list = Tag.objects.all()
    template = loader.get_template(
        'organizer/tag_list.html')
    context = RequestContext(
        request,
        {'tag_list': tag_list})
    output = template.render(context)
    return HttpResponse(output)


def tag_detail(request, slug):
    tag = get_object_or_404(
        Tag, slug__iexact=slug)
    template = loader.get_template(
        'organizer/tag_detail.html')
    context = RequestContext(
        request,
        {'tag': tag})
    return HttpResponse(template.render(context))
```

Understanding and using `RequestContext` or `Context` has a direct effect on our choice of shortcuts. Prior to Django 1.3, developers would force the `render_to_response()` shortcut to use the `RequestContext` object by coding as shown in Example 5.30.

Example 5.30: Python Code

```
return render_to_response(
    'path/to/template.html',
    data_dictionary,
    context_instance=RequestContext(request))
```

Many examples online and older projects continue to use this method. However, starting in Django 1.3 (released March 2011), developers should instead use the `render()` shortcut, which is identical to `render_to_response()` except that it uses a `RequestContext` object instead of a `Context` object and therefore takes the `HttpRequest` object as a third argument. Specifically, `render()` does the following:

1. Loads a template file as a `Template` object
2. Creates a `RequestContext` from a dictionary (with `HttpRequest`)
3. Calls all the context processors in the project, adding or modifying data to the `RequestContext`
4. Renders the `Template` with the `RequestContext`
5. Instantiates an `HttpResponse` object with the rendered result

The `render()` shortcut thus replaces the project code from Example 5.30, taking three arguments: `request`, the path to the template file, and the dictionary used to build the `RequestContext` object. We can follow the same replacement steps used for `render_to_response()` in the case of `render()`. Example 5.31 shows the resulting `/organizer/views.py`.

Example 5.31: Project Code
`organizer/views.py` **in** `d2ecb7f70d`

```
from django.shortcuts import (
    get_object_or_404, render)

from .models import Tag


def homepage(request):
    return render(
        request,
        'organizer/tag_list.html',
        {'tag_list': Tag.objects.all()})


def tag_detail(request, slug):
    tag = get_object_or_404(
        Tag, slug__iexact=slug)
    return render(
        request,
        'organizer/tag_detail.html',
        {'tag': tag})
```

Using `RequestContext` is slower than using `Context`, and therefore `render()` is slower than `render_to_response()` (when without the `context` argument). Nonetheless, most developers now use `render()` out of the box, choosing to prioritize ease of programming over performance. Using `Context` or `render_to_response()`,

particularly in young projects with few users, could be considered a pre-optimization, limiting functionality in favor of performance. In addition, context processors are not typically the bottleneck on a website. By the same token, if a context processor is ever needed on a view using `Context` or `render_to_response()`, more work will be required to get the context processor working, particularly if the developer is unclear as to where the problem lies. It is therefore not a bad idea to start with `RequestContext` and `render()` and replace them if necessary (and if possible!). We reinforce this notion in Chapter 19 when we opt to use variables created by context processors on every webpage.

In keeping with this logic and with current trends, the rest of the book relies on `render()` as the de facto view shortcut.

As we move forward, please keep in mind that while similar, `render_to_response()` and `render()` have very different uses, and many of the examples online should be using `render()` instead of `render_to_response()`, making this latter shortcut a common pitfall for beginners when building forms (Chapter 9) or when using the contributed library.

5.7 URL Configuration Internals: Adhering to App Encapsulation

We currently have two function views, now masterfully shortened, and two URL patterns, creating two webpages. However, our URL configuration is in direct violation of app encapsulation in Django. The URL patterns that direct users to the two webpages generated by the **organizer** app exist in a file that is for the project: the URLs are in a file under `suorganizer/`, as opposed to a file within the `organizer/` directory.

The practical goal of this section is to refactor our URL configuration so that our Django website adheres to the app encapsulation standard. However, to do so, we must learn much more about the URL configuration. The instructional goal of this section is to teach you exactly how URL patterns are used and built in Django.

5.7.1 Introspecting URL Patterns

We've discovered that a URL configuration is a list of URL patterns, stored by convention in a variable named `urlpatterns`. What I (and others) casually refer to as a *URL pattern* is actually a `RegexURLPattern` object. Each call to `url()` instantiates a `RegexURLPattern`; a URL configuration is thus a list of `RegexURLPattern` objects stored in a variable named `urlpatterns`.

Each `RegexURLPattern` is instantiated by a call to `url()` (see Example 5.32), which takes as mandatory arguments (1) a regular expression pattern and (2) a reference to a view. As an optional argument, it's possible to pass (3) a Python dictionary, where each key value is passed to the view as keyword arguments. We will see this in action before the end of the chapter and then again in Chapter 19. Finally, `url()` will accept (4) a named argument `name`, where we can specify the name of the `RegexURLPattern`. We've named our second URL pattern `organizer_tag_detail`, but the utility of names won't be clear until Chapter 6.

Example 5.32: Python Code

```
url(regular_expression,
    view,
    optional_dictionary_of_extra_values,
    name=a_name)
```

Ghosts of Django Past

Prior to Django 1.8, it was possible to point to a view using a string that acted as a Python namespace (similar to imports). For example, we could have used the line in Example 5.33.

Example 5.33: Python Code

```
url(r'^$', 'organizer.views.homepage')
```

What's more, while the `urlpatterns` variable was still a simple list, it was convention (but not necessary) to create and process the list using a call to the `patterns()` function, as in Example 5.34.

Example 5.34: Python Code

```
urlpatterns = patterns('',
    url(regular_expression, view),
)
```

The first argument to `patterns` was the string prefix, which worked in tandem with namespace strings. For instance, the URL configurations in Example 5.35 and Example 5.36 are equivalent.

Example 5.35: Python Code

```
urlpatterns = patterns('',
    url(regular_expression,
        'organizer.views.homepage'),
)
```

Example 5.36: Python Code

```
urlpatterns = patterns('organizer.views',
    url(regular_expression,
        'homepage'),
)
```

The use of `patterns` and namespace strings in URL patterns are deprecated and should not be used. Use direct Python imports (what we are currently using) instead.

Django uses the `ROOT_URLCONF` setting in `settings.py` to find the URL configuration for the project. It does so as soon as the server starts (along with settings). This makes Django fast, as the entire regular expression pattern-matching scheme is stored in memory once, but it also means that if you change the URL configuration or any settings, you must restart the Django server (unless you're running the development server, which anticipates changes).

Because a URL configuration is a list, the order of URL patterns matters, particularly when the URLs matched by regular expression patterns overlap. In Chapter 6, we will see an example of overlapping URLs and how order comes into play.

While we now understand the basics of URL patterns and configurations, we're still missing a key concept: how to connect different URL configurations.

5.7.2 Using `include` to Create a Hierarchy of URL Configurations

The second argument passed to `url()` need not point at a view: it can point at another URL configuration, thanks to the `include()` function. This capability allows us to create a separate URL configuration in each Django app and have a URL pattern in the site-wide URL configuration point to each one. In effect, the full URL configuration is not a simple list but is actually a tree, where the leaves of the tree are webpages (see Figure 5.6).

When a URL pattern points to a URL configuration, the regular expression pattern acts as a URI prefix. For instance, if the path `r'^blog/'` points to a URL configuration, then all of the URL patterns in that URL configuration will effectively have that URI prefixed to their own regular expression.

This functionality comes with an important pitfall: regular expression patterns in URL patterns that point to URL configurations must be treated as partial regular expression patterns: we cannot use the `$` character to close the pattern, or it will prevent the use of the ensuing patterns. If a URL pattern with the regular expression pattern `r'^first/$'` points

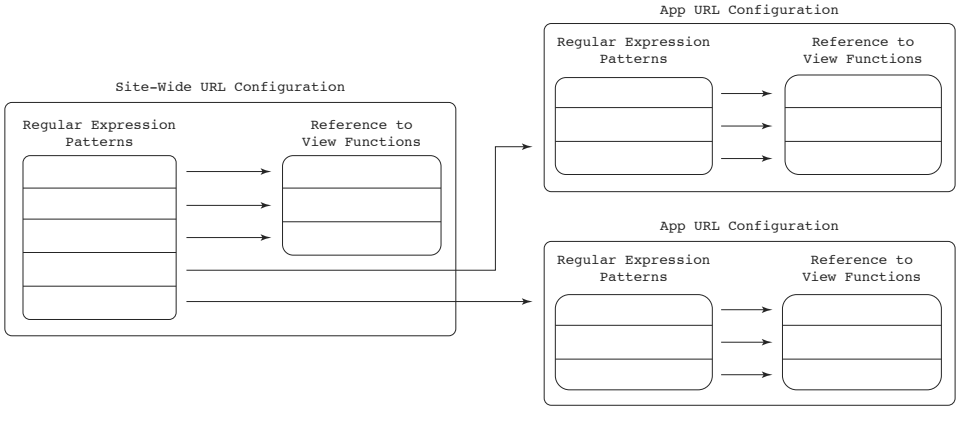

Figure 5.6: URL Configuration Tree

to a URL configuration with the regular expression pattern `r'^second/$'`, Django will *effectively* (but not actually, as we'll discuss shortly) combine them for the result of `r'^first/$second/$'`. Instead of matching `/first/second/` as desired, Django will only match `/first/`. To properly build this URL pattern, the first regular expression must remove the `$`, reading `r'^first/'`, so that the combination results in `r'^first/second/$'`, as in Example 5.37.

Example 5.37: Python Code

```
# app/urls.py
urlpatterns = patterns(
    url(r'^second/$',
        a_view),
)

# project/urls.py
import app.urls as app_url_config

urlpatterns = patterns(
    url(r'^first/',  # there is no '$' here!
        include(app_url_config)),
)
```

Django is not actually combining regular expressions but rather truncating the URL path it receives. For this reason, the `^` can still be used in `r'^second/$'`. When a user requests `/first/second/`, Django removes the first `/`, resulting in a request for `first/second/`. Django then uses regular expression pattern `r'^first/'` to match `first/second/`. This explains why we cannot use the `$`: `r'^first/'` will match `first/second/`, but `r'^first/$'` will not. Once Django has selected this URL pattern, it uses the regular expression pattern `r'^first/'` to truncate the path from `first/second/` to `second/`, allowing the regular expression pattern `r'^second/$'` to match this new path.

Given Django's behavior, a second pitfall is the omission of slashes in intermediate paths. Django only removes the root slash of any URL path. If we use a regular expression pattern `r'^first'` (no slash or `$`) to point a URL pattern to a URL configuration containing a URL pattern with a regular expression pattern `r'^second/$'`, it will match not `/first/second/` but instead `/firstsecond/`, which is probably not desirable.

What's more, the behavior described above provides us with the reason to always use the `^` regular expression character at the beginning of every regular expression pattern. Without it, we stand to erroneously match URL paths. If we are now using `r'^first/'` and `r'second/$'` (no `^`), it will validly match `/first/whoops/second/`, which is probably not what we want either.

We don't actually apply most of this information until we build our **blog** URL configuration. For our **organizer** app, we don't want to prefix our path with anything yet. (We will in Chapter 11: Bending the Rules: The Contact Us Webpage when we want the

path /tag/ and /startup/, not /organizer/tag/ or /organizer/startup/.) The prefix we use now is therefore empty.

Start by creating a new file, /organizer/urls.py. In it, we create a new URL configuration. We import the url() function to create RegexURLPattern objects. We then create a urlpatterns list to allow Django to find our URL configuration. We can then call url() with the same parameters as the ones currently in /suorganizer/urls.py. We end up with a /organizer/urls.py file which reads as in Example 5.38.

Example 5.38: Project Code
organizer/urls.py **in** 18f1a2d3bc

```
 1  from django.conf.urls import url
 2
 3  from .views import homepage, tag_detail
 4
 5  urlpatterns = [
 6      url(r'^$', homepage),
 7      url(r'^tag/(?P<slug>[\w\-]+)/$',
 8          tag_detail,
 9          name='organizer_tag_detail'),
10  ]
```

To direct Django to this new URL configuration, we need to point our root URL configuration file to this new file using the include() function, already included in the Python imports. To start, we need to import the URLs from our **organizer** app. To avoid name-space clashes, we use the as keyword to rename the urls module organizer_urls. We can then simply point include() to this Python reference. We do this by using the ^ regular expression pattern character, shown in Example 5.39.

Example 5.39: Project Code
suorganizer/urls.py **in** 18f1a2d3bc

```
16  from django.conf.urls import include, url
17  from django.contrib import admin
18
19  from organizer import urls as organizer_urls
20
21  urlpatterns = [
22      url(r'^admin/', include(admin.site.urls)),
23      url(r'^', include(organizer_urls)),
24  ]
```

If you are still running the development server, it will automatically detect the changes made and reload your URL configuration. If not, restart it by invoking runserver on the command line, as shown in Example 5.40.

Example 5.40: Shell Code

```
$ ./manage.py runserver
```

With the development server running, you can now browse to `127.0.0.1:8000` to see our `homepage()` view and `127.0.0.1:8000/tag/mobile/` to demonstrate our `tag_detail()` view. Consider that while our URL configuration has changed, the URLs we are able to use have not. We have refactored code, not added new behavior.

5.8 Implementing the Views and URL Configurations to the Rest of the Site

We now have a fundamental understanding of URL configurations and views and have two fully functional webpages using the best tools at our disposal. With these tools, we will now build the rest of the webpages in our site.

5.8.1 Restructuring Our `homepage()` View

Before we build out new views, it is in our best interest to change our `homepage()` view to give it a more sensible name and URL path.

Given that it is a list of `Tag` objects, we should replace the URL pattern so that it matches `tag/` as the URL path and provide it with a name, `organizer_tag_list`, as demonstrated in Example 5.41 in `/organizer/urls.py`.

Example 5.41: Project Code
`organizer/urls.py` **in** `1f86398a5e`

```
 1  from django.conf.urls import url
 2
 3  from .views import tag_detail, tag_list
 4
 5  urlpatterns = [
 6      url(r'^tag/$',
 7          tag_list,
 8          name='organizer_tag_list'),
 9      url(r'^tag/(?P<slug>[\w\-]+)/$',
10          tag_detail,
11          name='organizer_tag_detail'),
12  ]
```

Note that we use `^` and `$` in the URL pattern starting on line 6 to carefully define the start and end of the URL path.

In our `/organizer/views.py` file, we thus need to rename our `homepage()` view to `tag_list()`, as in Example 5.42. We make no other changes.

Example 5.42: Project Code
`organizer/views.py` **in** `1f86398a5e`

```
16  def tag_list(request):
17      return render(
18          request,
19          'organizer/tag_list.html',
20          {'tag_list': Tag.objects.all()})
```

Given our changes, `http://127.0.0.1:8000/` is no longer a valid URL. Django notes the result of our changes by displaying the list of valid URL patterns, indicating that we may browse to `http://127.0.0.1:8000/tag/` or `http://127.0.0.1:8000/tag/<slug>/`, such as `http://127.0.0.1:8000/tag/mobile/`, to display valid pages.

5.8.2 Building a `Startup` List Page

In `/organizer/urls.py`, we begin by creating a URL pattern for a startup list page, as shown in Example 5.43. Our new URL pattern will direct requests for URL path `startup/` to the function view `startup_list()`.

Example 5.43: Project Code
`organizer/urls.py` **in** `69767312bf`

```
 3  from .views import (
 4      startup_list, tag_detail, tag_list)
 .      ...
 6  urlpatterns = [
 7      url(r'^startup/$',
 8          startup_list,
 9          name='organizer_startup_list'),
 .      ...
16  ]
```

In `/organizer/views.py`, we may follow the example of our `Tag` object list view when building one for `Startup` objects. In Example 5.44, we load and render the template we built for this purpose and pass in all of the `Startup` objects in the database to the name of the template variable, which we earlier named `startup_list`.

Example 5.44: Project Code
`organizer/views.py` **in** `69767312bf`

```
 4  from .models import Startup, Tag
 .      ...
 7  def startup_list(request):
 8      return render(
 9          request,
10          'organizer/startup_list.html',
11          {'startup_list': Startup.objects.all()})
```

Remember to add the imports, as shown in Examples 5.43 and 5.44!

5.8.3 Building a `Startup` Detail Page

As we did for our `tag_detail()` view, we will now build a `startup_detail()` view. The function will show a single `Startup` object, directed to in the URL by the `slug` field of the model. Our function view thus must take not only a `request` argument but also a `slug` argument. In `/organizer/views.py`, enter the code shown in Example 5.45.

Example 5.45: Project Code
`organizer/views.py` **in** `bb3aa7eb88`

```
 7  def startup_detail(request, slug):
 8      startup = get_object_or_404(
 9          Startup, slug__iexact=slug)
10      return render(
11          request,
12          'organizer/startup_detail.html',
13          {'startup': startup})
```

As before, we use the `slug` value passed by the URL configuration to query the database via the Django-provided `get_object_or_404`, which will display an HTTP 404 page in the event the `slug` value passed does not match one in the database. We then use `render()` to load a template and pass the `startup` object yielded by our query to the template, to be rendered via the template variable of the same name.

In `/organizer/urls.py`, we direct Django to our new view by adding the URL pattern shown in Example 5.46.

Example 5.46: Project Code
`organizer/urls.py` **in** `bb3aa7eb88`

```
 3  from .views import (
 4      startup_detail, startup_list, tag_detail,
 5      tag_list)
 .      ...
 7  urlpatterns = [
 .      ...
11      url(r'^startup/(?P<slug>[\w\-]+)/$',
12          startup_detail,
13          name='organizer_startup_detail'),
 .      ...
20  ]
```

Note again the `^` and `$` characters that define the beginning and end of our URL path and how our use of regular expression named groups allows us to pass the slug portion of the URL directly to our view as a keyword argument. We make sure, as always, to name the URL pattern.

5.8.4 Connecting the URL Configuration to Our Blog App

We've created the four display webpages in our **organizer** app. We will now build two pages in our **blog** app. To maintain app encapsulation, we must first create an app-specific URL configuration file and then point a URL pattern in the site-wide URL configuration to it.

Start by creating `/blog/urls.py` and coding the very basic requirements for a URL configuration. This will yield the code shown in Example 5.47.

Example 5.47: Project Code
`blog/urls.py` **in** `02dabec093`

```
1  urlpatterns = [
2  ]
```

In `/suorganizer/urls.py` we can direct Django to our **blog** app URL configuration thanks to `include()`, as shown in Example 5.48.

Example 5.48: Project Code
`suorganizer/urls.py` **in** `02dabec093`

```
19  from blog import urls as blog_urls
 .      ...
22  urlpatterns = [
 .      ...
24      url(r'^blog/', include(blog_urls)),
 .      ...
26  ]
```

Remember that the full URL configuration is actually a tree. If a URL pattern points to another URL configuration, Django will pass the next URL configuration a truncated version of the URL path. We can thus continue to use the `^` regular expression character to match the beginning of strings, but we cannot use the `$` to match the end of a string. When the user requests the blog post webpage, he or she will request `/blog/2013/1/django-training/`. Django will remove the root slash and match the URL path in the request to the URL pattern above, as the regular expression `r'^blog/'` matches the path. Django will use the regular expression pattern `r'^blog/'` to truncate the path to `2013/1/django-training/`. This is the path it will forward to the **blog** URL configuration and is what we want our post detail view to match.

Before we create a blog post detail view, let us first program a list view for posts.

5.8.5 Building a `Post` List Page

With our **blog** app connected via URL configuration, we can now add URL patterns. Let's start with a list of blog posts.

In `/blog/views.py`, our function view is straightforward, as you can see in Example 5.49.

Example 5.49: Project Code
`blog/views.py` **in** `928c982c03`

```
from django.shortcuts import render

from .models import Post


def post_list(request):
    return render(
        request,
        'blog/post_list.html',
        {'post_list': Post.objects.all()})
```

We wish to list our blog posts at `/blog/`. However, this is already the URL path matched by our call to `include` in `suorganizer/urls.py`. When a user requests `/blog/`, Django will remove the root `/`, and match the URL pattern we just built. Django will then use `r'^blog/'` to truncate the path from `blog/` to the empty string (i.e., nothing). We are thus seeking to display a list of blog posts when Django forwards our **blog** app the empty string. In Example 5.50, we match the empty string with the regular expression pattern `r'^$'`.

Example 5.50: Project Code
`blog/urls.py` **in** `928c982c03`

```
from django.conf.urls import url

from .views import post_list

urlpatterns = [
    url(r'^$',
        post_list,
        name='blog_post_list'),
]
```

5.8.6 Building a `Post` Detail Page

The final view left to program is our detail view of a single `Post` object. Programming the view and URL pattern for this view is a little bit trickier than our other views: the URL for each `Post` object is based not only on the slug but also on the date of the object, making the regular expression pattern and query to the database a little more complicated. Recall that we are enforcing this behavior in our `Post` model via the `unique_for_month` attribute on the `slug`.

Take `http://site.django-unleashed.com/blog/2013/1/django-training/` as an example. After `include()` in our root URL configuration truncates

`blog/` from the URL path, our **blog** app URL configuration will receive `2013/1/django-training/`. Our regular expression pattern must match a year, month, and slug and pass each one as a value to our view.

The year is four digits, and our named group is thus `(?P<year>\d{4})`. A month may have one or two digits, so our named group is `(?P<month>\d{1,2})`. Finally, and as before, our slug is any set of alphanumeric, underscore, or dash characters with length greater than one, so we write our named group as `(?P<slug>[\w\-]+)`. We separate each part of the URL path with a `/` and wrap the string with `^` and `$` to signify the beginning and end of the URL path to match. The string containing our regular expression is thus `r'^(?P<year>\d{4})/(?P<month>\d{1,2})/(?P<slug>[\w\-]+)/$'`.

To direct Django to a view in `/blog/views.py`, we may write the call in Example 5.51 to `url()`.

Example 5.51: Project Code
`blog/urls.py` **in** `cb5dd59383`

```
 3  from .views import post_detail, post_list
 .      ...
 5  urlpatterns = [
 .      ...
 9      url(r'^(?P<year>\d{4})/'
10          r'(?P<month>\d{1,2})/'
11          r'(?P<slug>[\w\-]+)/$',
12          post_detail,
13          name='blog_post_detail'),
14  ]
```

Warning!

In Example 5.51, we are passing **one regular expression pattern**, despite that there appears to be three. Python allows strings to be split into string fragments as long as there is only whitespace between the string fragments. Note how lines 9 and 10 do not end with a comma, while line 11 does. This is because the strings on lines 9, 10, and 11 are all a single string to Python, split this way to fit on the pages of this book. The `r` preceding the string fragments makes each fragment a raw string.

Our function view will thus accept four parameters: `request`, `year`, `month`, and `slug`.

In Example 5.52, in `/blog/views.py`, start by changing the import to include `get_object_or_404`, which we will need for our detail page.

Example 5.52: Project Code
`blog/views.py` **in** `cb5dd59383`

```
1  from django.shortcuts import (
2      get_object_or_404, render)
```

We must now build a query for the database. Our `Post` model contains a `pub_date` field, which we could compare to a `datetime.date`, but we don't have the necessary information to build one (we lack the day). For the occasion, Django provides `DateField` and `DateTimeField` objects with special field lookups that break each field down by its constituents, allowing us to query `pub_date__year` and `pub_date__month` to filter results. In the case of our example URL, `http://site.django-unleashed.com/blog/2013/1/django-training/`, this functionality allows us to write the query shown in Example 5.53.

Example 5.53: Python Code

```
Post.objects
    .filter(pub__date__year=2014)
    .filter(pub__date__month=11)
    .get(slug__iexact='django-training')
```

While the query to our `Post` model manager will work, it is more desirable to use the `get_object_or_404` to minimize developer-written code. Recall that `get_object_or_404` wants a model class and a query string as parameters. Django does not limit the number of query strings passed to `get_object_or_404`, allowing developers to pass as many as necessary. Given *n* arguments, the first *n*-1 will call `filter()`, while the *n*th will result in a call to `get()`. Practically, this means Django will re-create the query in Example 5.53 for us exactly, with the call shown in Example 5.54.

Example 5.54: Project Code
`blog/views.py` **in** `cb5dd59383`

```
 8       post = get_object_or_404(
 9           Post,
10           pub_date__year=year,
11           pub_date__month=month,
12           slug=slug)
```

The rest of our view is exactly like any other. The view passes the `HttpRequest` object, a dictionary, and a string to `render()`. The `render()` shortcut uses the `HttpRequest` object and the dictionary to build a `RequestContext` object. The string passes a path to the template file, allowing `render()` to load the template and render the template with the `RequestContext` object. The shortcut then returns an `HttpResponse` object to the view, which the view passes on to Django. Our final view is thus shown in Example 5.55.

Example 5.55: Project Code
`blog/views.py` **in** `cb5dd59383`

```
 7   def post_detail(request, year, month, slug):
 8       post = get_object_or_404(
```

```
 9           Post,
10           pub_date__year=year,
11           pub_date__month=month,
12           slug=slug)
13       return render(
14           request,
15           'blog/post_detail.html',
16           {'post': post})
```

5.9 Class-Based Views

Warning!

This section deals with Python *methods* and *HTTP methods*. I will refer to Python methods simply as *methods* and to HTTP methods as *HTTP methods*, typically referring to the actual HTTP method in capitals (such as the HTTP GET method or the HTTP OPTIONS method).

Any Python callable that accepts an `HttpRequest` object as argument and returns an `HttpResponse` object is deemed a view in Django. So far, we've stuck exclusively to using Python functions to create views. Prior to Django 1.3, this was the only recommended way to create views. However, starting in version 1.3, Django introduced a class to allow developers to create view objects.

Django introduced a class to create view objects because coding the class for the view is actually rather tricky and prone to security issues. For this reason, despite the ability to use any Python callable as a view, developers stick to using the Django recommended class or else simply use functions.

The class itself is simply called `View`, and developers refer to classes that inherit `View` as class-based views (CBVs). These classes behave exactly like function views but come with several unexpected benefits.

To begin, let's replace our `Post` list function view with a class-based view. Example 5.56 shows our current view.

Example 5.56: Project Code
`blog/views.py` **in** `cb5dd59383`

```
19  def post_list(request):
20      return render(
21          request,
22          'blog/post_list.html',
23          {'post_list': Post.objects.all()})
```

We are not going to change the logic of the function. However, the function must become a method belonging to a class (which implies the addition of the `self` parameter, required for Python methods). We may name the class whatever we wish, so we shall call it

`PostList`, but for reasons discussed shortly, the name of the method must be `get()`, as shown in Example 5.57.

Example 5.57: Project Code
`blog/views.py` **in** `d9b8e788d5`

```
 3  from django.views.generic import View
 .      ...
20  class PostList(View):
21
22      def get(self, request):
23          return render(
24              request,
25              'blog/post_list.html',
26              {'post_list': Post.objects.all()})
```

The import of `View` typically causes beginners confusion because it implies that `View` is generic, leading people to confuse `View` and class-based views with *generic* class-based views (GCBVs). *GCBVs are not the same as CBVs, and making a distinction between the two is crucial.* We wait until Chapter 17 and Chapter 18 to deal with GCBVs. For the moment, know that we are building CBVs and that they are different from GCBVs.

Our `PostList` class inherits from the `View` class we imported, imbuing it with (currently unseen) behavior.

The significance of the name of the method `get()` is that it refers to the HTTP method used to access it (a primer on HTTP methods is provided in Appendix A). Therefore, our method will be called only if the user's browser issues an HTTP GET request to a URL that is matched by our URL pattern. To contrast, if an HTTP POST request is made, Django will attempt to call the `post()` method, which will result in an error because we have not programmed such a method. We'll come back to this shortly.

In `/blog/urls.py`, import the `PostList` class and then change the URL pattern pointer to the pattern shown in Example 5.58.

Example 5.58: Project Code
`blog/urls.py` **in** `d9b8e788d5`

```
3   from .views import PostList, post_detail
.       ...
.   urlpatterns = [
.       ...
.       url(r'^$',
.           PostList.as_view(),
.           name='blog_post_list'),
.       ...
.   ]
```

The `as_view()` method is provided by the inheritance of the `View` superclass and ensures that the proper method in our CBV is called. When Django receives an HTTP

GET request to a URL that matches the regular expression in our URL pattern, `as_view()` will direct Django to the `get()` method we programmed. We'll take a much closer look at exactly how shortly.

5.9.1 Comparing Class-Based Views to Functions Views

A CBV can do everything a function view can do. We've not seen the use of the URL pattern dictionary previously, and so we'll now take the opportunity to use a dictionary in both a function view and a CBV to demonstrate similarities. The practical purpose of our dictionary is to override the base template of our view (which we defined in Chapter 4 in the template as `parent_template`), and the learning purpose is to familiarize you with the URL pattern dictionary and CBVs.

To start, we add the dictionary to both **blog** URL patterns, as shown in Example 5.59.

Example 5.59: Project Code
`blog/urls.py` **in** `d3030ee8d3`

```
 5  urlpatterns = [
 6      url(r'^$',
 7          PostList.as_view(),
 8          {'parent_template': 'base.html'},
 9          name='blog_post_list'),
10      url(r'^(?P<year>\d{4})/'
11          r'(?P<month>\d{1,2})/'
12          r'(?P<slug>[\w\-]+)/$',
13          post_detail,
14          {'parent_template': 'base.html'},
15          name='blog_post_detail'),
16  ]
```

In our `post_detail` function view, shown in Example 5.60, we must add a named parameter that's the same as the key in the dictionary (if we had several keys, we'd add several parameters).

Example 5.60: Project Code
`blog/views.py` **in** `d3030ee8d3`

```
8   def post_detail(request, year, month,
9                   slug, parent_template=None):
```

To follow through with our example, we need to pass the argument to our template. In Example 5.61, we add `parent_template` to the context dictionary defined in the `render()` shortcut.

Example 5.61: Project Code
`blog/views.py` **in** `d3030ee8d3`

```
15      return render(
16          request,
17          'blog/post_detail.html',
18          {'post': post,
19           'parent_template': parent_template})
```

The process for using the dictionary is almost identical to a CBV. We first add a new parameter to the `get()` method and then pass the new argument to `render()`, as shown in Example 5.62.

Example 5.62: Project Code
`blog/views.py` **in** `d3030ee8d3`

```
22  class PostList(View):
23
24      def get(self, request, parent_template=None):
25          return render(
26              request,
27              'blog/post_list.html',
28              {'post_list': Post.objects.all(),
29               'parent_template': parent_template})
```

The modification illustrates a key point with CBVs: the view is entirely encapsulated by the class methods. The CBV is a container for multiple views, organized according to HTTP methods. At the moment, illustrating this more directly is impossible, but we revisit the concept in depth in Chapter 9. The bottom line at the moment is that any modification you might make to a function view occurs at the method level of a CBV.

We're not actually interested in overriding the base templates of our views and so should revert the few changes we've made in this section.

5.9.2 Advantages of Class-Based Views

The key advantages and disadvantages of CBVs over function views are exactly the same advantages and disadvantages that classes and objects have over functions: encapsulating data and behavior is typically more intuitive but can easily grow in complexity, which comes at the cost of functional purity.

A staple of object-oriented programming (OOP) is the use of instance variables, typically referred to as **attributes** in Python. For instance, we can usually better adhere to DRY in classes by defining important values as attributes. In `PostList`, we replace the string in `render()` with an attribute (which contains the same value), as shown in Example 5.63.

Example 5.63: Project Code
`blog/views.py` **in** `ac3db8b26b`

```
20  class PostList(View):
21      template_name = 'blog/post_list.html'
22
23      def get(self, request):
24          return render(
25              request,
26              self.template_name,
27              {'post_list': Post.objects.all()})
```

At the moment, this does us little good on the DRY side of things, but it does offer us a level of control that function views do not offer. Quite powerfully, CBVs allow for existing class attributes to be overridden by values passed to `as_view()`. Should we wish to change the value of the `template_name` class attribute, for example, we need only pass it as a named argument to `as_view()` in the `blog_post_list` URL pattern, as shown in Example 5.64.

Example 5.64: Project Code
`blog/urls.py` **in** `78947978fd`

```
6       url(r'^$',
7           PostList.as_view(
8               template_name='blog/post_list.html'),
9           name='blog_post_list'),
```

Even if the `template_name` attribute is unset, the view will still work as expected because of the value passed to `as_view()`, as shown in Example 5.65.

Example 5.65: Project Code
`blog/views.py` **in** `78947978fd`

```
20  class PostList(View):
21      template_name = ''
```

However, if the `template_name` attribute is undefined (we never set it in the class definition), then `as_view` will ignore it.

In the event that `template_name` is unset and the developer forgets to pass it, we should be raising an `ImproperlyConfigured` exception. We will see its use in Chapter 17.

Once again, we're not actually interested in the advantages presented by the changes made in this section, and so I will revert all of the changes made here in the project code.

5.9.3 `View` Internals

CBVs also come with several much subtler advantages. To best understand these advantages, it's worth diving into the internals of `View` and seeing exactly what we're inheriting when we create a CBV.

The easiest place to start is with `as_view()`. In a URL pattern, we use `as_view()` to reference the CBV. Example 5.66 shows an example generic URL pattern.

Example 5.66: Python Code

```
url(r'^(?P<slug>[\w\-]+)/$',
    CBV.as_view(class_attribute=some_value),
    {'dict_key': 'dict_value'},
    name='app_model_action')
```

The `as_view()` method is a static class method (note that we call `PostList.as_view()` and not `PostList().as_view()`) and acts as a factory; `as_view()` returns a view (a method on the instance of `PostList`). Its main purpose is to define a (nested) function that acts as an intermediary view: it receives all the data, figures out which CBV method to call (using the HTTP method), and then passes all the data to that method, as shown in Example 5.67.

Example 5.67: Python Code

```
# grossly simplified for your benefit
@classonlymethod
def as_view(cls, **initkwargs)
    def view(request, *args, **kwargs)
        # magic!
    return view
```

In Example 5.67, the `cls` parameter will be the CBV. In our `blog_post_list` URL pattern, `as_view()` will be called with `cls` set to `PostList`. When we passed `template_name` to `as_view()` in `blog_post_list`, `initkwargs` received a dictionary in which `template_name` was a key. Example 5.68 shows the result.

Example 5.68: Python Code

```
as_view(
    cls=PostList,
    initkwargs={
        'template_name': 'blog/post_list.html',
    })
```

To best behave like a view, the nested `view()` method first instantiates the CBV as the `self` variable (demonstrating exactly how flexible Python is as a language). The `view()` method then sets a few attributes (removed from the example code) and calls the `dispatch()` method on the newly instantiated object, as shown in Example 5.69.

Example 5.69: Python Code

```
# still quite simplified
@classonlymethod
def as_view(cls, **initkwargs)
    def view(request, *args, **kwargs)
        self = cls(**initkwargs)
        ...
        return self.dispatch(request, *args, **kwargs)
    return view
```

For clarity's sake, I want to reiterate that passing undefined attributes to `as_view()` will result in problems because `as_view()` specifically checks for the existence of these attributes and raises an `TypeError` if it cannot find the attribute, as shown in Example 5.70.

Example 5.70: Python Code

```
# still quite simplified
@classonlymethod
def as_view(cls, **initkwargs)
    for key in initkwargs:
        ...
        if not hasattr(cls, key):
            raise TypeError(...)
    def view(request, *args, **kwargs)
        self = cls(**initkwargs)
        ...
        return self.dispatch(request, *args, **kwargs)
    return view
```

If `as_view()` is the heart of `View`, then `dispatch()` is the brain. The `dispatch()` method, returned by `view()`, is actually where the class figures out which method to use. `dispatch()` anticipates the following developer-defined methods: `get()`, `post()`, `put()`, `patch()`, `delete()`, `head()`, `options()`, `trace()`. In our `PostList` example, we defined a `get()` method. If a `get()` method is defined, `View` will automatically provide a `head()` method based on the `get()` method. In all cases, `View` implements an `options()` method for us (the HTTP OPTIONS method is used to see which methods are valid at that path).

In the event the CBV receives a request for a method that is not implemented, then `dispatch()` will call the `http_method_not_allowed()` method, which simply returns

an `HttpResponseNotAllowed` object. The `HttpResponseNotAllowed` class is a subclass of `HttpResponse` and raises an HTTP 405 "Method Not Allowed" code, informing the user that that HTTP method is not handled by this path.

This behavior is subtle but very important: by default, function views are not technically compliant with HTTP methods. At the moment, all of our views are programmed to handle GET requests, the most basic of requests. However, if someone were to issue a PUT or TRACE request to our pages, *only the `PostList` CBV will behave correctly* by raising a 405 error. All of the other views (function views) will behave as if a GET request had been issued.

If we wanted, we could use the `require_http_methods` function decorator to set which HTTP methods are allowed on each of our function views. The decorator works as you might expect: you tell it which HTTP methods are valid, and any request with other methods will return an HTTP 405 error. For example, to limit the use of GET and HEAD methods on our `Post` detail view, we can add the decorator, as demonstrated in Example 5.71.

Example 5.71: Project Code
`blog/views.py` **in** `34baa4dfc3`

```
 3  from django.views.decorators.http import \
 4      require_http_methods
 .      ...
10  @require_http_methods(['HEAD', 'GET'])
11  def post_detail(request, year, month, slug):
```

> **Info**
> The use of `@require_http_methods(['GET', 'HEAD'])` is common enough that Django provides a shortcut decorator called `require_safe` to help shorten your code by just a bit.

Even so, the decorator doesn't provide automatic handling of OPTIONS, and organizing multiple views according to HTTP method results in simpler code, as we shall see in Chapter 9.

5.9.4 Class-Based Views Review

A CBV is simply a class that inherits `View` and meets the basic requirements of being a Django view: a view is a Python callable that always accepts an `HttpRequest` object and always returns an `HttpResponse` object.

The CBV organizes view behavior for a URI or set of URIs (when using named groups in a regular expression pattern) according to HTTP methods. Specifically, `View` is built such that it expects us to define any of the following: `get()`, `post()`, `put()`, `patch()`, `delete()`, `trace()`. We could additionally define `head()`, `options()`, but `View` will automatically generate these for us (for `head()` to be automatically generated, we must define `get()`).

Internally, the CBV actually steps through multiple view methods for each view. The `as_view()` method used in URL patterns accepts `initkwargs` and acts as a factory by returning an actual view called `view()`, which uses the `initkwargs` to instantiate our CBV and then calls `dispatch()` on the new CBV object. `dispatch()` selects one of the methods defined by the developer, based on the HTTP method used to request the URI. In the event that the method is undefined, the CBV raises an HTTP 405 error.

In a nutshell, `as_view()` is a view factory, while the combination of `view()`, `dispatch()`, and any of the developer-defined methods (`get()`, `post()`, etc.) are the actual view. Much like a function view, any of these view methods must accept an `HttpRequest` object, a URL dictionary, and any regular expression group data (such as `slug`). In turn, the full combined chain (`view()`, `dispatch()`, etc.) must return an `HttpResponse` object.

At first glance, CBVs are far more complex than function views. However, CBVs are more clearly organized, allow for shared behavior according to OOP, and better adhere to the rules of HTTP out of the box. We will further expand on these advantages, returning to the topic first in Chapter 9.

Our understanding of views will change in Chapter 9 and Chapter 17, but at the moment, the rule of thumb is as follows: if the view shares behavior with another view, use a CBV. If not, you have the choice between a CBV and a function view with a `require_http_methods` decorator, and the choice is pure preference. I personally stick with CBVs because I find the automatic addition of the HTTP OPTIONS method appealing, but many opt instead to use function views.

5.10 Redirecting the Homepage

If you run Django's development server and navigate to the root of the website, you'll discover that we've missed a spot, as shown in Example 5.72.

Example 5.72: Shell Code

```
$ ./manage.py runserver
```

Browsing to `http://127.0.0.1:8000/` will display an error page telling us the URL configuration doesn't have a route for this page. While we've created a very detailed and clean URL configuration for all of our URLs, we've omitted the homepage, the root of our website.

We want to show the list of blog posts on the homepage. There are several ways we can go about doing so.

5.10.1 Directing the Homepage with URL Configurations

The first and perhaps most obvious way would be to create a new URL pattern to send the route to the view we have already built. In `/suorganizer/urls.py`, we could add the URL pattern shown in Example 5.73 to the URL configuration.

Example 5.73: Project Code
`suorganizer/urls.py` **in** `3ddb5f3810`

```
20  from blog.views import PostList
 .      ...
23  urlpatterns = [
24      url(r'^$',
25          PostList.as_view()),
 .      ...
29  ]
```

The regular expression pattern: `^` starts the pattern, while `$` ends the pattern. This matches `''`, which is what the root of the URL is to Django, given that it always strips the first `/`.

Similarly, given that the `PostList` view is the root of the **blog** URL configuration, the URL pattern could also be as shown in Example 5.74.

Example 5.74: Project Code
`suorganizer/urls.py` **in** `4dc1d03a79`

```
23      url(r'^$', include(blog_urls)),
```

Neither of the solutions presented above is desirable, as they both corrupt the cleanliness and simplicity of our site URLs. In the first instance, `http://site.django-unleashed.com/blog/` and `http://site.django-unleashed.com/` are now exactly the same. In the second case, we have created an entire branch of URLs, which is far worse. Not only are `http://site.django-unleashed.com/blog/` and `http://site.django-unleashed.com/` the same page, but so is `http://site.django-unleashed.com/blog/2013/1/django-training/` and `http://site.django-unleashed.com/2013/1/django-training/` (note the missing `blog/` in the second URL path). This will effectively create a duplicate of every URL the **blog** already matched.

Our website should maintain a clean URL scheme. Short of creating a separate homepage view, directing our homepage to an existing view as above is undesirable.

5.10.2 Redirecting the Homepage with Views

Rather than simply displaying a webpage on our homepage, we will instead redirect the user to the desired URL. In this instance, `http://site.django-unleashed.com/` will redirect to `http://site.django-unleashed.com/blog/`, which is the `post_list()` view.

To redirect a URL, we need a view. This creates a minor problem: we are redirecting our site-wide homepage with a view, which at this point exists only in app directories. However, this code does not belong in either our **organizer** or **blog** apps. Although Django does not

anticipate the need for site-wide `views.py`, nothing is stopping us from creating `/suorganizer/views.py`. Inside, we write the code shown in Example 5.75.

Example 5.75: Project Code
`suorganizer/views.py` **in** `2e8036623d`

```
1  from django.http import HttpResponseRedirect
2
3
4  def redirect_root(request):
5      return HttpResponseRedirect('/blog/')
```

The `HttpResponseRedirect` class is a subclass of `HttpResponse` with special properties, just like `HttpResponseNotFound`. Given a URL path, it will redirect the page using an HTTP 302 code (temporary redirect). Should you wish for an HTTP 301 code (permanent redirect), you could instead use `HttpResponsePermanentRedirect`. Note that doing so in development can result in unexpected behavior because the browser will typically cache this response, resulting in difficulties should you change the behavior.

In `/suorganizer/urls.py`, we can import the new view and replace our previous URL pattern with the one in Example 5.76.

Example 5.76: Project Code
`suorganizer/urls.py` **in** `2e8036623d`

```
22  from .views import redirect_root
23
24  urlpatterns = [
25      url(r'^$', redirect_root),
 .      ...
29  ]
```

Running the deployment server with `$ ./manage.py runserver` and navigating a browser to `http://127.0.0.1:8000/` will result in a redirect to `http://127.0.0.1:8000/blog/`.

The behavior is what we desire, but our implementation could be improved. Instead of using `HttpResponseRedirect`, we can use a Django shortcut, `redirect()`. Our `/suorganizer/views.py` will now look like Example 5.77.

Example 5.77: Project Code
`suorganizer/views.py` **in** `5fb0dff63a`

```
1  from django.shortcuts import redirect
2
3
4  def redirect_root(request):
5      return redirect('/blog/')
```

The code in Example 5.77 will work exactly as if we were still using `HttpResponseRedirect`, with an HTTP 302 code. Should we wish to switch to an HTTP 301 code, we could pass `permanent=True` to the shortcut, as in: `redirect('/blog/', permanent=True)`.

The advantage to `redirect()` is that, unlike HttpResponseRedirect, it does not need a URL path (currently used in Example 5.77). To better adhere to the DRY principle, we can instead use the name of the URL pattern we wish to redirect to, as shown in Example 5.78.

Example 5.78: Project Code
`suorganizer/views.py` **in** `ba8c7c5e89`

```
4   def redirect_root(request):
5       return redirect('blog_post_list')
```

The shortcut in Example 5.78 is exactly what we want, but it may be a little opaque. Unlike the shortcuts we've seen before, we don't currently understand everything going on under the hood. Specifically, we don't know how the shortcut builds a proper URL path from the URL pattern. We will see exactly how to do this in the next chapter and revisit this shortcut then.

Note that our way of redirecting, with a site-wide function view, is not the way you would redirect in an actual project. Our method is in direct violation of DRY, but we won't be able to fix that until Chapter 17.

In short, the behavior above is exactly what we want, and the code is the best we can write given our current knowledge. Please keep this function and behavior in mind going forward, as we will revisit it in Chapter 6 and replace it in Chapter 17.

5.11 Putting It All Together

In Chapter 5, we examined Django views and URL configurations, which make up the Controller of Django's Model-View-Controller architecture. The Controller acts as the glue between the Model and View. In Django, the Controller receives, selects, processes, and then returns data.

A Django view is any callable that receives an `HttpRequest` object (with any other additional arguments) and returns an `HttpResponse` object. Originally, Django recommended using functions as views, but modern Django also provides a canonical way of creating classes to create object views.

To make writing views easier, Django supplies shortcut functions. We saw three shortcuts, starting with `get_object_or_404()`, which gets an object according to a model class and query while accounting for the possibility that the query will not match a row in the database, in which case it raises a `Http404` exception. We then saw the `render_to_response()` and `render()`. Both load a template, render the template with a context, and instantiate an `HttpReponse` object with the result. However, the `render()` shortcut uses a `RequestContext` instead of a `Context` object, allowing Django to run context processors on the `RequestContext`, effectively adding values for the template to

use during the rendering phase. This added functionality is key to certain views and functionality, and thus `render()` has become the favored shortcut, even if it is marginally slower than `render_to_response()`.

To direct Django to the views the developer writes, Django provides the URL configuration mechanism. The URL configuration is contained in a file pointed to by the project settings. Inside the file, Django expects (by convention) to find the `urlpatterns` variable, which is a list of `RegexURLPattern` objects. Each `RegexURLPattern` object is created by a call to `url()`, which expects at the very least (1) a regular expression pattern and (2) a reference to a Python callable. A call to `url()` may also optionally be called with (3) a dictionary of values that are passed as keywords to the view that the resulting `RegexURLPattern` points to. Finally, `url()` can receive (4) the keyword argument `name`, which sets the name of the `RegexURLPattern`, a feature that will become crucial in the next chapter.

URL configurations may be connected using `include()`. A URL pattern may include another URL configuration, allowing for the creation of a URL scheme that is a tree, where the root URL configuration specified in the Django project settings is the root of the tree. This feature furthermore allows for app encapsulation, allowing each app to define its own URL patterns, extending those of the project, which `include()` achieves by truncating the regular expression match from the URL path requested of Django.

In short, the URL configuration directs Django to the view thanks to URL pattens, which contains the logic required to make a webpage.

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