Full Stack Python
Guide to Deployments

by Matthew Makai

The Full Stack Python Guide to Deployments

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Who This Book is For

If you are a beginner to intermediate Python developer learning how to web applications and want to learn more about deploying web apps, then this is exactly the book for you.

There are many deployment tutorials on the web, many of which are linked to on Full Stack Python. However, you'd need to piece together many of those tutorials and read between the lines to get a complete end-to-end deployment successfully completed. With this book, you will not need to worry about guessing what to do next. We will walk through every step and explain it so you know what you're doing and why it needs to be done.

If you've already deployed numerous Python web applications and are managing several Python apps in production, this is not the book for you because we are starting with the assumption that you don't have any pre-existing knowledge about deployments.

Purpose

This book supplements the writing and material found on the Full Stack Python website with completely new content. Full Stack Python (FSP) contains explanations of Python programming concepts, recommendations for how to learn and links to tutorials found around the web. However, FSP does not provide step-by-step instructions for performing an end-to-end Python web application deployment.

Over the past several years of writing FSP, I have received numerous requests from the programming community for more comprehensive details tutorials. This book is the result of those requests. My hope is that this guide helps folks as much as the FSP website.

How to Use this Book

If you've never deployed a Python web application before my recommendation is to go through the book twice. First, go through the manual steps and take your time understanding the individual components, such as WSGI servers, as well as the overall picture of how the implementations fit together once they are deployed. Once you understand the manual deployment process then set up a second, separate server and work through each chapter's deployment automation steps.

Learning how to automate deployments with Ansible will be most useful for folks who have already manually deployed web applications and have a grasp on basic systems administration. If you're coming to this book with prior deployment experience then skim through the manual steps in each chapter before moving on to the automated deployment instructions.

Revision History

2016-09-08: **September 2016 edition**. Major clarification text and improvements to all chapters based on further reader feedback. Changed from using Ulysses Mac app to Prince PDF generator, pandoc and Kindlegen for ebook generation, which should allow for faster new edition releases. Open sourced and released gitbook-code-highlighter on npm that was built for this book when I was trying to get gitbook working as the generation tool. Updated screenshots for Namecheap and other services.

2015-12-03: **December 2015 edition**. Clean up and clarifications on confusing sections throughout chapters 4, 6, 7 and 10. A huge thank you to Zev Averbach for his tweets and issue tickets on GitHub that allowed me to reproduce some problems he had going through several sections.

2015-08-26: **August 2015 edition**. Typo and link fixes throughout the book.

2015-07-28: **First edition**. Initial release.

Feedback and Updates

This book is updated regularly based on reader feedback. I am to put out an update every one or two months, depending on how busy I am with my day gig at Twilio. Anyone who purchases the book will get access to updates for free.

To encourage early purchases and keep myself motivated to crank out new brand concept, over time I may raise the price slightly for people who haven not yet purchased the book. For example, if I knock out a new chapter with instructions on integrating unit tests into the continuous integration server, I may raise the price slightly from $24 to $26. Anyone who has already purchased the book will not have to pay for a new copy or the difference between the new and old prices.

There are several scenarios that call for updates:

1. Incorporate updated software releases. For example, Ubuntu comes out with a new Long Term Support (LTS) version.
2. Write new content and chapters to expand the deployment in the book.
3. Fix or clarify issues with the walkthrough based on community feedback.

Let me know via email at matthew.makai@gmail.com whenever you run into confusing wording, inaccurate code snippets and general rough patches while going through the book. Thank you!

About the Book Cover

The cover photo is a picture I took while in Paris standing near the edge of the Le Seine. The picture was then cropped and edited in Pixelmator to give it the sketch effect. A good portion of core content for the book was written in Paris which made it seem like an appropriate picture.

The picture for the cover was deliberately taken on the ground level, in contrast to the cover picture for the Full Stack Python book edition which shows a view from above the clouds. This book is a hands-on, step-by-step guide for deployments that is complementary to the 20,000 foot deployments overview given by Full Stack Python.

Thank you

To Char, for her constant encouragement and telling me to "just release it already". To Luke and my parents, for inspiring me and listening to me say month after month that it would be released "any day now." To Twilio and the Developer Network, because I would sure as hell never be able to write

technical content at a level of excellence without what I have learned from you all since I started on the crew.

Technical reviewers

Special thanks to my technical reviewers Andrew, Dylan and Kate for their feedback on numerous drafts of the book throughout many months of writing.

Andrew Baker

Andrew Tork Baker is a software developer based in Washington, DC. He works at Twilio on their Developer Education team, devising new ways to teach people about programming. Though his current job exposes him to many different programming languages, Python and its community will always be his first choice. Andrew also organizes the Django District meetup in DC.

Andrew is the instructor for O'Reilly's Introduction to Docker video, blogs at http://www.andrewtorkbaker.com and can be reached on GitHub via atbaker and Twitter @andrewtorkbaker.

Dylan Fox

Dylan Fox is a software developer at Cisco Systems, where he's part of a new Innovation team focused on building new collaboration technologies. He got into programming and Python while working on a startup he founded in college. Dylan can be reached on GitHub via dylanbfox and Twitter @YouveGotFox.

Kate Heddleston

Kate Heddleston is a web applications developer in the Bay Area who has been using Python and Django since graduation. She received her M.S. in CS at Stanford with an undergrad degree in communication. Kate enjoys using open-source tools to build web applications, and especially likes to build product features that interface with the user. She believes that open-source technologies are the foundation of our modern tech-driven world and that automation is one of the core values that technology offers us. Thus, open-source automation tools are some of Kate's favorite things in the world, just

below puppies and just above shoe shopping. Kate can be reached on GitHub via heddle317 and Twitter @heddle317.

Table of Contents

Chapter 1

Introduction

Introduction

You've built the first version of your Python-powered web application. Now you want anyone around the world with an Internet connection to be able to use what you've created. However, before it's possible for others to access your application you need to configure a production server and deploy your code so it is running properly in that environment.

How do you go about handling the entire deployment? What about subsequent deployments when your code changes? Even if you've previously deployed a web application there are many moving pieces in the process that can be frustratingly difficult to handle.

That's where The Full Stack Python Guide to Deployments comes in. This book will guide you step-by-step through every task necessary to deploy a Python web application.

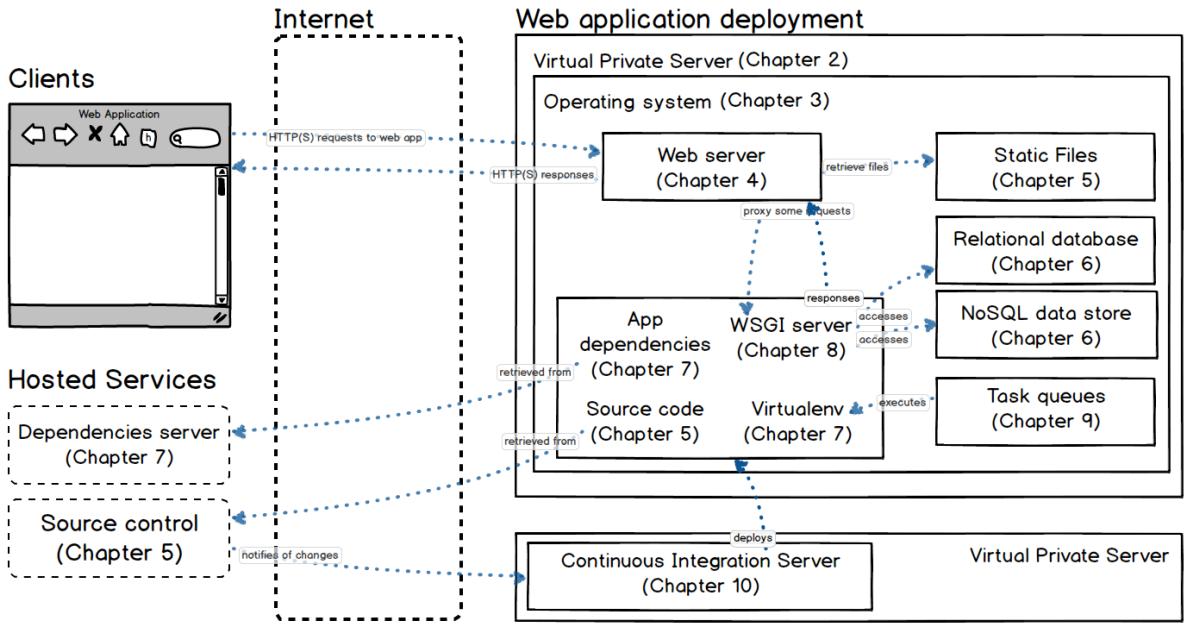
Each chapter in this book will teach you how to manually configure a part of the deployment pipeline and explain what you are accomplishing with that step. With the knowledge you learn from working through each step manually, we'll then use Fabric and Ansible to automate the deployment process. At the end of each chapter you will not only understand what you are doing but you will also have the steps automated for future deployments.

Our Deployment

Throughout this book we'll work through setting up the infrastructure to run a production version of a Python web application. All code will be deployed on a single virtual private server.

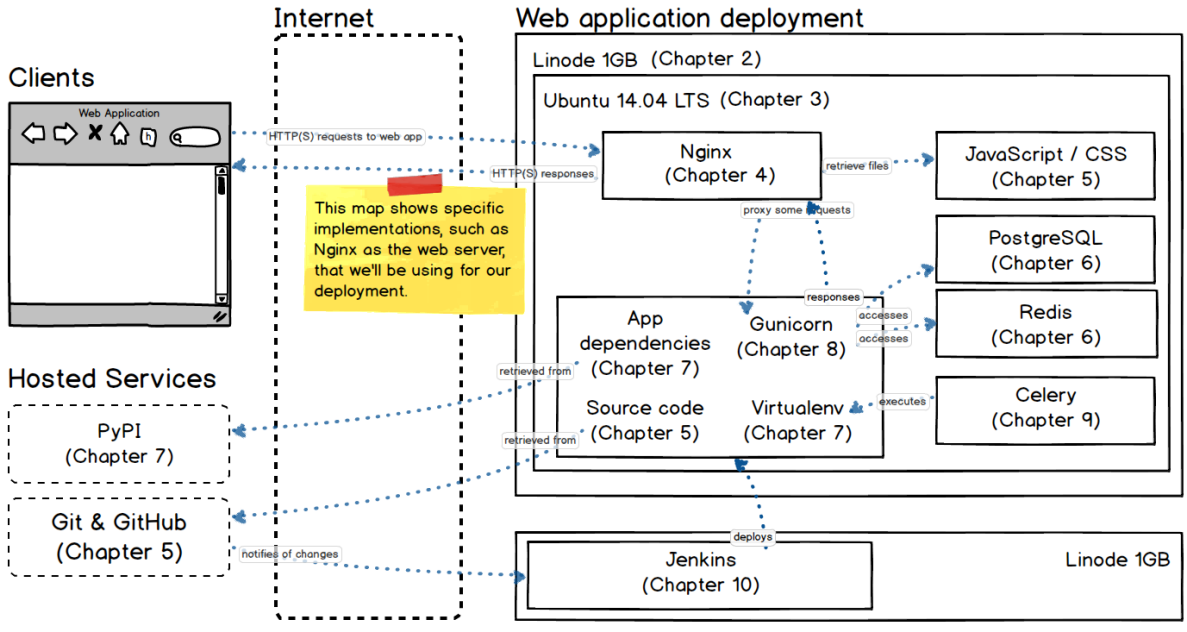
It's okay if some of the technical terms, such as production server or WSGI, are confusing to you! You will learn the terms' definitions and how the pieces fit together as we go along. There is also a technical terms appendix for reference that you can find near the end of the book.

The picture below this paragraph is a deployment concepts map of the book's content. Each chapter in this book contains this map with a highlight on the concept and software we will configure in that chapter.



The above map shows concepts such as web servers and web frameworks. These concepts are abstractions, not specific implementations of Python software projects. For example, the abstract concept of a web server is implemented by the Nginx (pronounced "Engine-X") server, which we will install and configure in the Web Servers chapter.

The below map has the same structure as the above map but replaces the concepts with their implementations for our deployment pipeline.



Again, don't worry if you are unfamiliar with the concepts or implementations shown in the above maps. Each chapter will introduce a concept, explain how to set up the implementation manually, automate the steps and give additional resources to continue learning more advanced topics on the subject.

Deployment Automation

This book teaches you how to automate your application deployments even if you've never done systems administration work before. Once you understand how deployments work and have automation in place, you can quickly iterate on your code in your development environment then immediately get working code out to your production server.

Automation is critical for keeping running web applications up to date with the most recently developed code. Once your application is live on the production server, users will give you feedback, request changes and discover bugs. The faster you can fix those issues and add enhancements the better chance your application will succeed. Automated deployments provide the speed and reliability to keep the code running in production up to date even if you make many changes each day.

Every step in the deployment is automated as we work our way through the chapters. There is an open source repository on GitHub with the automation code, as well as Git tags for the incremental steps performed in each chapter. The following links take you to each chapter's corresponding tag on GitHub:

- 01-introduction: just the README and a stub directory for SSH keys
- 02-servers: Fabric `fabfile.py` in the `prod` subdirectory
- 03-operating systems: start of the Ansible playbook
- 04-web-servers: builds the Nginx configuration into the Ansible playbook
- 05-source-control: adds Git repository cloning to the playbook
- 06-databases: sets up PostgreSQL and Redis
- 07-application-dependencies: installs Python packages into a virtualenv, establishes environment variables and syncs the app to the database
- 08-wsgi-servers: configures Supervisor to run the app with Green Unicorn

- 09-task-queues: adds to the Supervisor configuration for Celery and Redis
- 10-continuous-integration: modifies the Ansible playbook so it does not prompt for the `sudo` password on the CI server

Tags may be added to the repository in the future when new chapters are added to this book.

Services and Code We'll Use

In this book use several services to get our environment up and running. You don't need to set these accounts up right now as we'll walk through them in the chapters where they are necessary. If you have accounts for these services already then you're one step ahead. The services are:

- Linode: hosts our virtual private production server - a single 1 gigabyte RAM virtual private server costs $10 / month
- GitHub: handles source control in the deployment - a free account works well
- Twilio: automates deployment alerts - either a free trial account or an upgraded account is fine

GitHub and Twilio can be used with the free trial account for our purposes.

We also need several free open source projects to handle the deployment, including:

- Fabric: provides a convenient way to script SSH commands with Python code
- Ansible: an easy to use but powerful configuration management automation tool
- Nginx: the second most common web server currently deployed that is also popular with the Python community
- Green Unicorn: a Web Server Gateway Interface (WSGI) server that will execute our Python code so we can run our web application

A local Linux or Mac OS X environment is required to perform the deployment. If you're on Windows you can install VirtualBox on your machine to run Ubuntu Linux 14.04 LTS. Here is a handy tutorial for installing VirtualBox on Windows if you need to do that before we get started.

Throughout the book we're going to use an open source project as the example code to deploy. Our web application uses the Flask web framework and follows the Python Web Server Gateway Inteface (WSGI) standard defined by the Python community in PEP 3333 for deploying web applications to web application servers. PEP 3333 specifies that WSGI frameworks such as Django, Flask and Pyramid can be interchangeably deployed to WSGI servers such as Gunicorn, mod_wsgi and uWSGI.

Our example WSGI application in this book is a Flask project which serves up Reveal.js presentations that allow audiences to live vote by sending text messages to the application via a phone number. The votes are calculated in the Flask application and immediately displayed in the presentation via a WebSocket connection. The app is called Choose Your Own Deployment Adventure Presentations. The code was used at DjangoCon US 2014 for a talk named "Choose Your Own Django Deployment Adventure" given by Kate Heddleston and myself. The following screenshot shows what the application looks like with the default presentation styling.

A benefit of using the Choose Your Own Deployment Adventure Presentations code as our example is that there is a detailed walkthrough for building the application (part 1, part 2, part 3 and part 4) on the Twilio blog. The full four-

part tutorial is also included as Appendix C in this book with some tweaks for easier reading. The code is well documented and released under the MIT license.

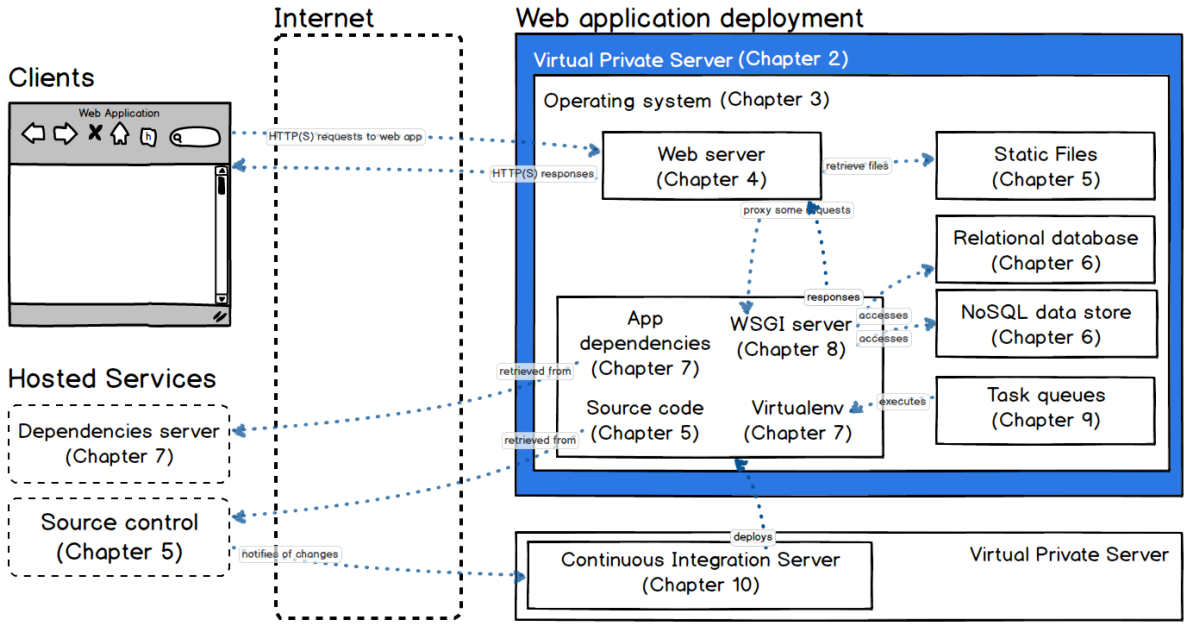
Time to get started with our web application deployment by obtaining a production server from Linode.

Chapter 2

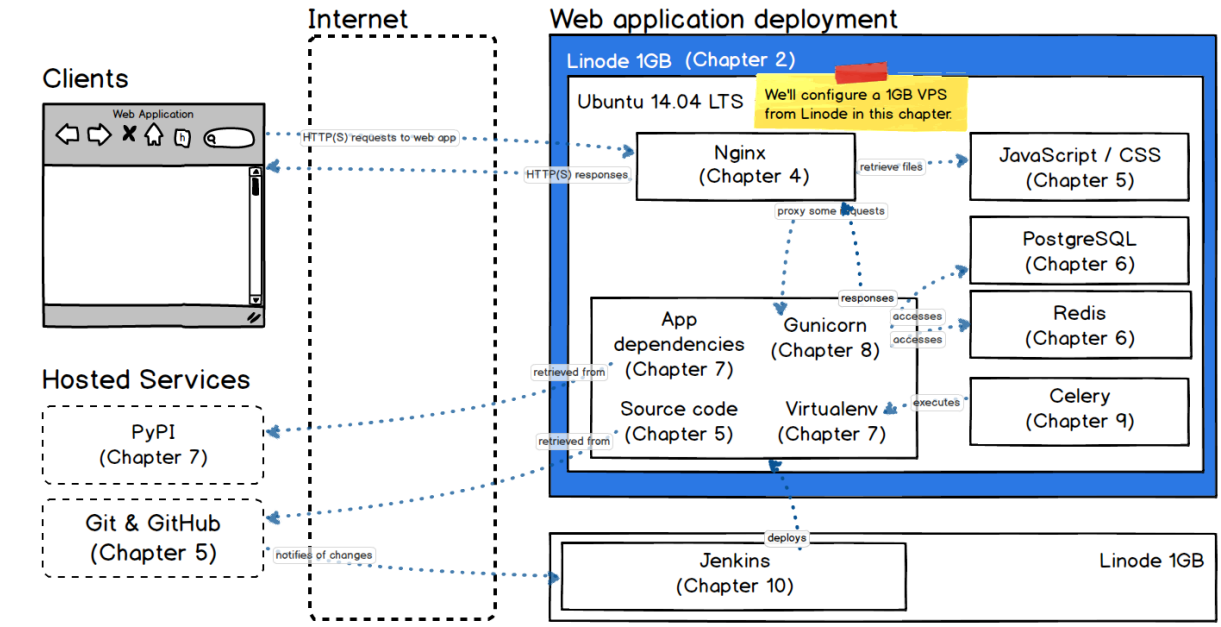
Servers

Servers

Your web application must run somewhere other than your development environment on your desktop or laptop. That location is a separate server (or cluster of servers) known as a "production environment". Throughout this book, we will use a single server for our application's production environment deployment.



In this chapter we'll take a look at several hosting options, obtain a virtual private server to use as our production environment, boot up the server and secure it against unauthorized access attempts.



As shown in the above diagram, Linode will provide us with a virtual private server for our production environment in this deployment.

Hosting Options

Let's consider our hosting options before diving into the deployment on the Linode virtual private server. There are four general options for deploying and hosting a web application:

- *"Bare metal" servers*: physical hardware; vendor examples: Dell, Lenovo
- *Virtual private servers*: shared rented portions of servers, examples: Linode, Digital Ocean
- *Infrastructure-as-a-service (IaaS)*: virtualized abstractions of resources, examples: Amazon Web Services & Microsoft Azure
- *Platform-as-a-service (PaaS)*: abstracted execution environments such as Heroku, Python Anywhere or Amazon Elastic Beanstalk

Bare metal servers and virtual private servers are similar. A base operating system such as Linux is installed with `root` access and the ability to configure (or totally screw up!) the system. System packages, a web server, WSGI server, database and the Python environment can be installed with the

customer preferences necessary for the deployment. The application code can be pulled from a source controlled repository and deployed so the application can run within the Python environment.

Infrastructure-as-a-service platforms such as Amazon Web Services and Microsoft Azure and platforms-as-a-service like Heroku are separate topics that are not covered in this book.

In this book we will deploy our web application on a virtual private server (VPS). There are plenty of VPS hosting options. I have used Linode for over six years now. They are a stable company with solid support when issues occur, which is rarely. You typically get what you pay for in the VPS hosting industry.

If you are considering a different provider make sure to check the resources section at the end of this chapter for evaluating VPS alternatives. The deployment instructions for this book will still work fine with any other VPS provider except that you will have to provision a virtual server yourself.

What are Virtualized Servers?

Virtual private servers (VPSs) are sandboxed slices of hardware run with a hypervisor running on top of a physical server. Virtualization software such as Xen and VMWare allow a providers' customers to use fractions of a full server that appear as their own independent instances. For example, a server with an 8-core processor and 16 gigabytes of memory can be roughly virtualized into 8 pieces with the equivalent of 1-core and 2 gigabytes of memory.

The primary disadvantage of virtualized servers is that there is resource overhead in the virtualization process. But for our web application deployment, a single well-configured virtual private server provides more than enough performance and represents a huge cost savings over purchasing dedicated hardware.

Let's obtain a Linode account, provision a server and get our deployment started.

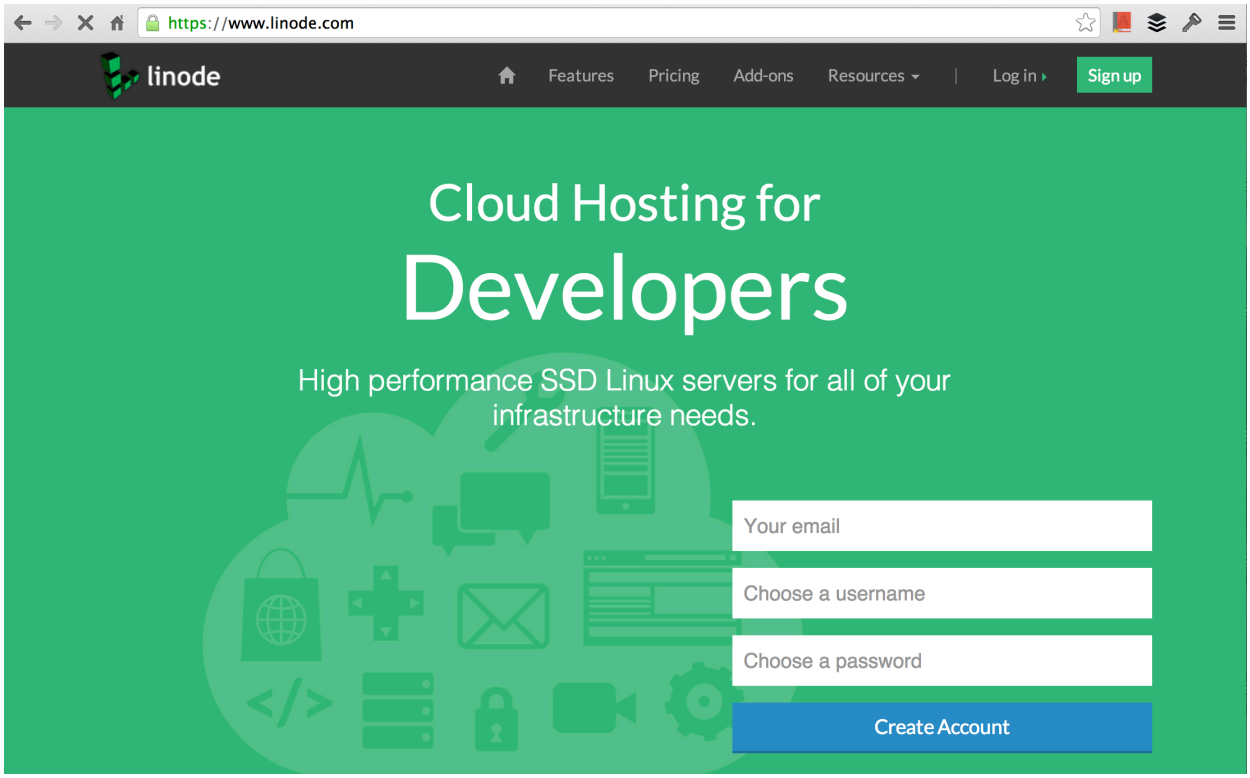
Obtain Your Virtual Server

These steps sign you up for a Linode account and guide you through provisioning a virtual private server for $10/month which we configure throughout the rest of the book.

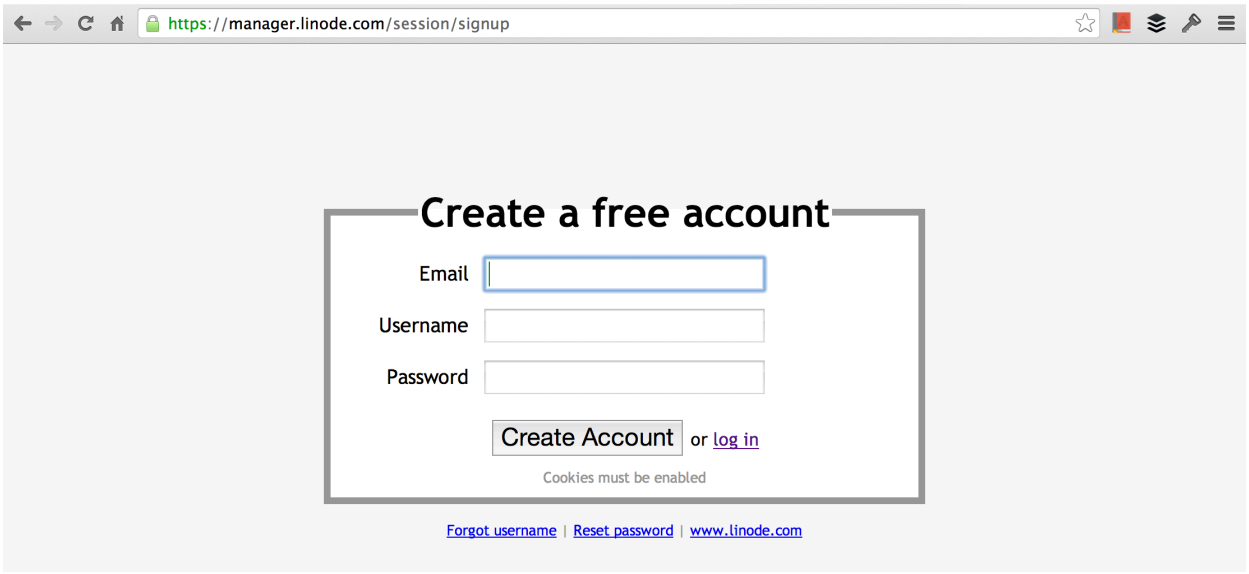
A note before we get started. Throughout this book the instructions will follow a standard format. Each step will explain what to do along with some context, such as a screenshot or snippet of code you'll need to type in. Within the code snippets there are lines prefixed with `#` that are comments. You don't have to type the comments in, they just provide additional context for what the commands are specifically doing and why the steps are necessary.

With that note out of the way, let's provision a Linux server so we can begin the deployment.

Point your web browser to Linode.com. Their landing page will look something like the following image.



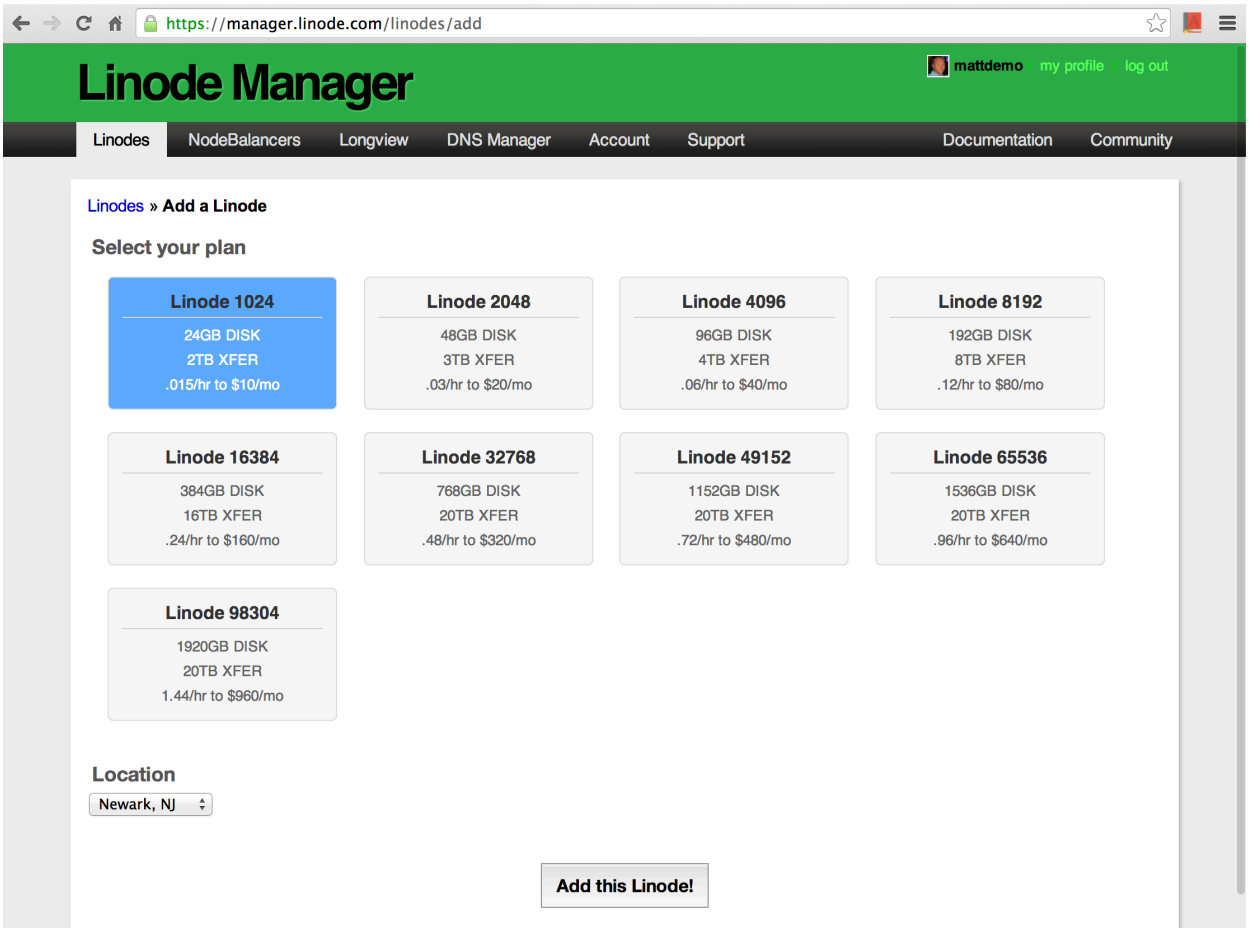
Sign up for an account.



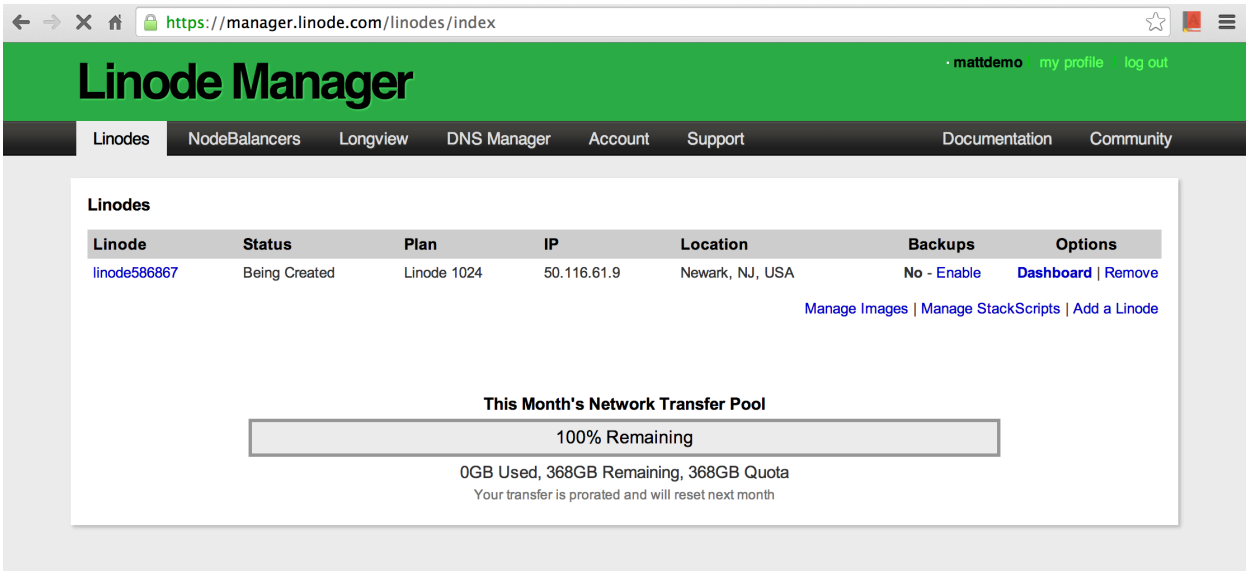
You should receive an email for account confirmation. Fill out the appropriate information and add initial credit to your account. If you want to enter a referral code, mine is `bfeecaf55a83cd3dd224a5f2a3a001fdf95d4c3d`. Your account will go for a quick review to ensure you are not a malicious spam bot and then your account will be fully activated.

Once your account is activated refresh the page. The new page will allow you to add a Linode instance.

Select the 1024 option, month-to-month billing and the data center location of your choice. I chose Newark, NJ because I grew up in northern NJ and otherwise the location isn't important for my deployment. If your most of your users are located in a specific region then you should select the data center location closest to them.

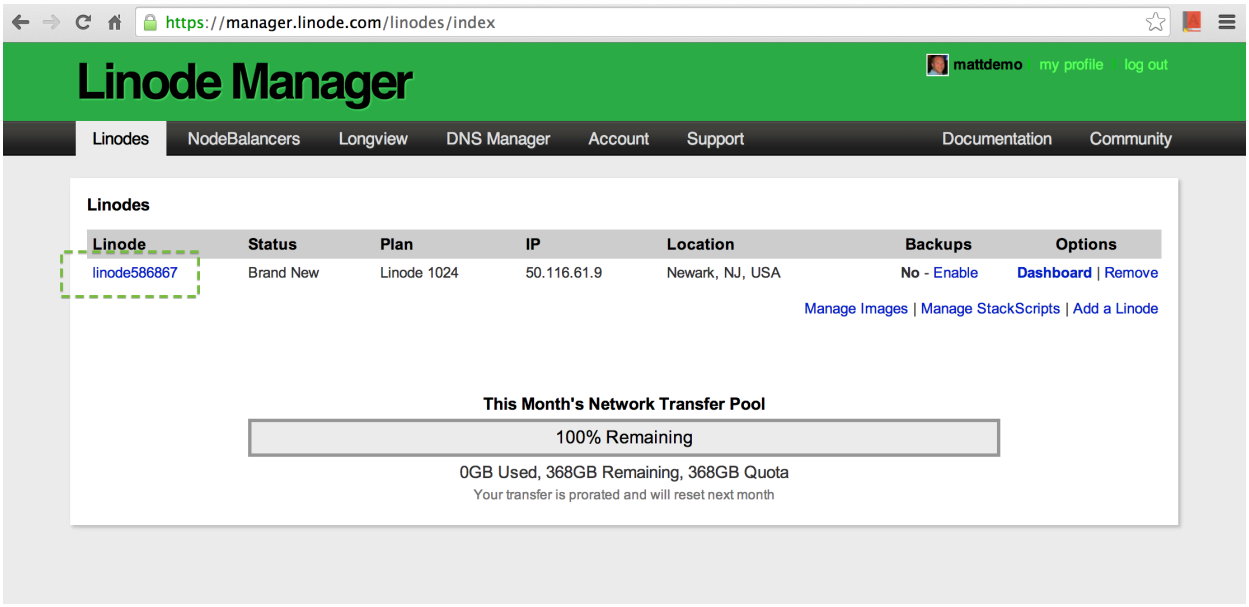


Click the "Add this Linode!" button and a dashboard will appear that shows the Linode is being provisioned.

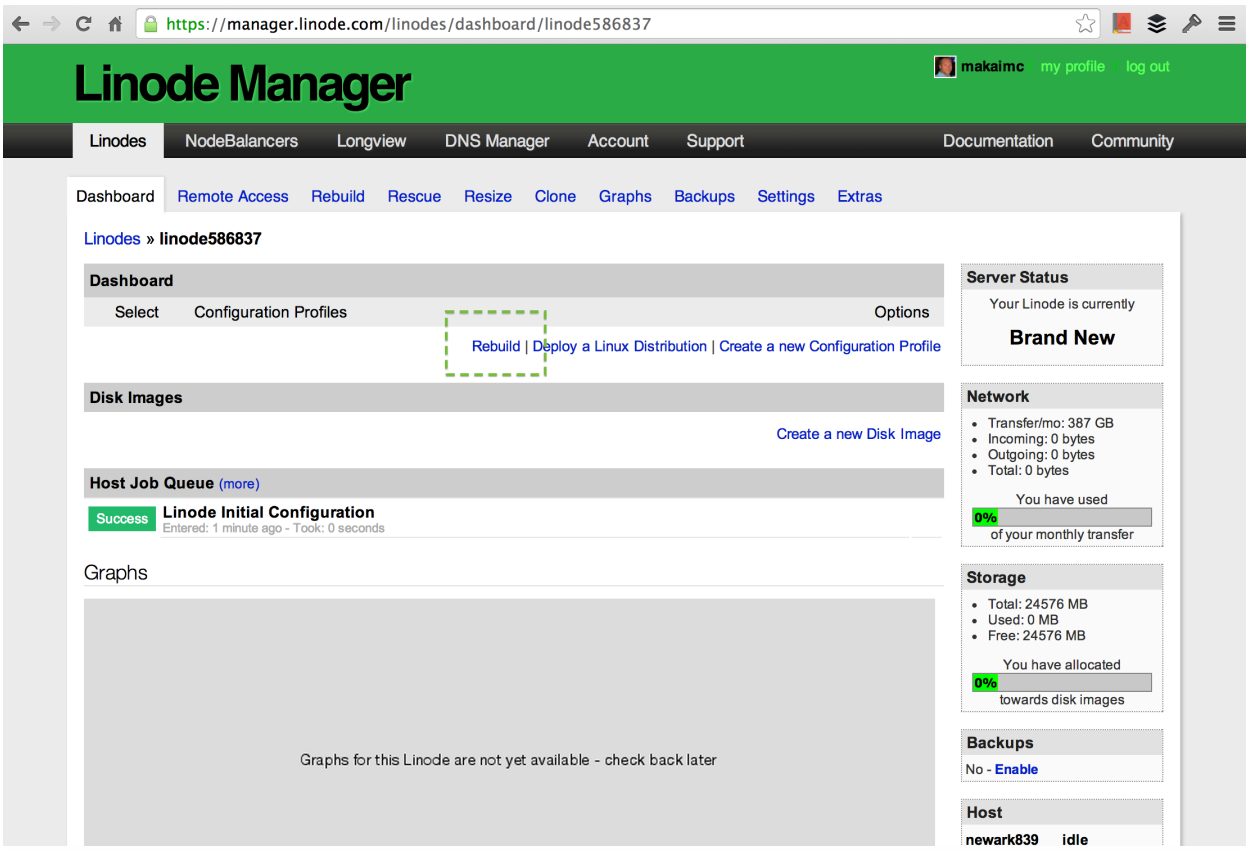


Refresh the page and look for the status to change to "Brand New." Write down or copy the IP address as it will be needed later to SSH into the server,

then click on the name of the Linode. A page will appear to show more information about your new virtual private server.

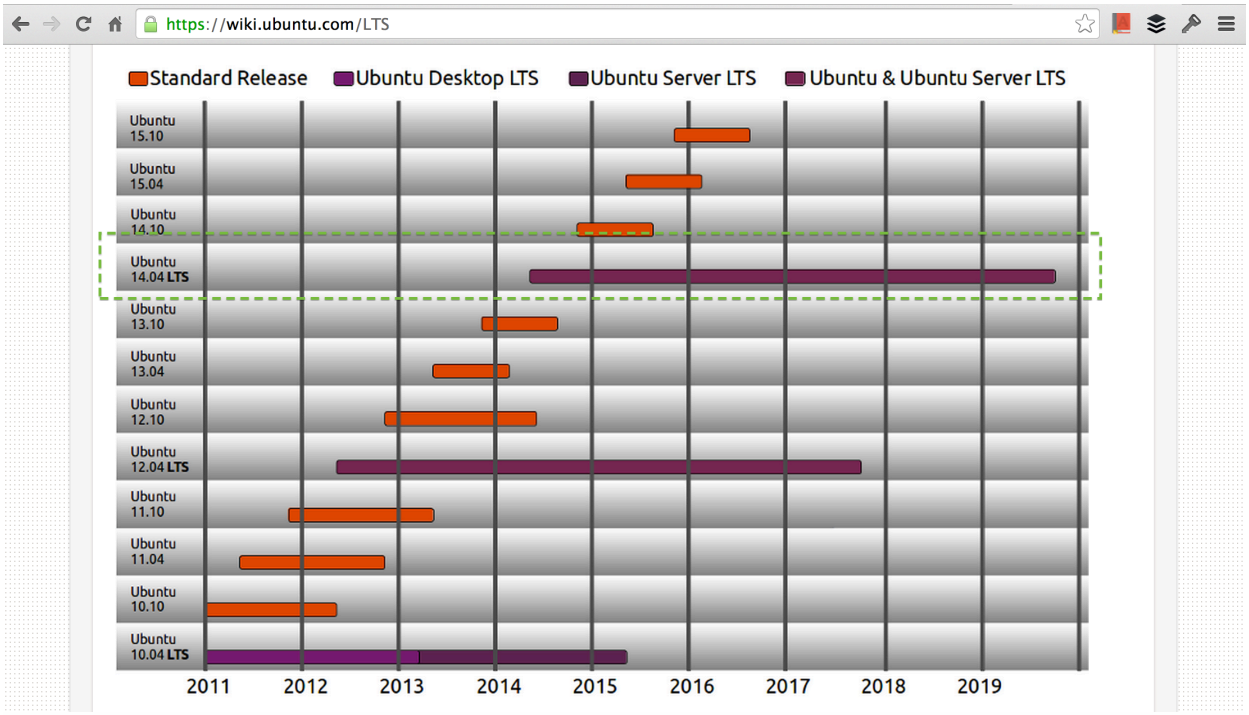


Click the "Rebuild" link.

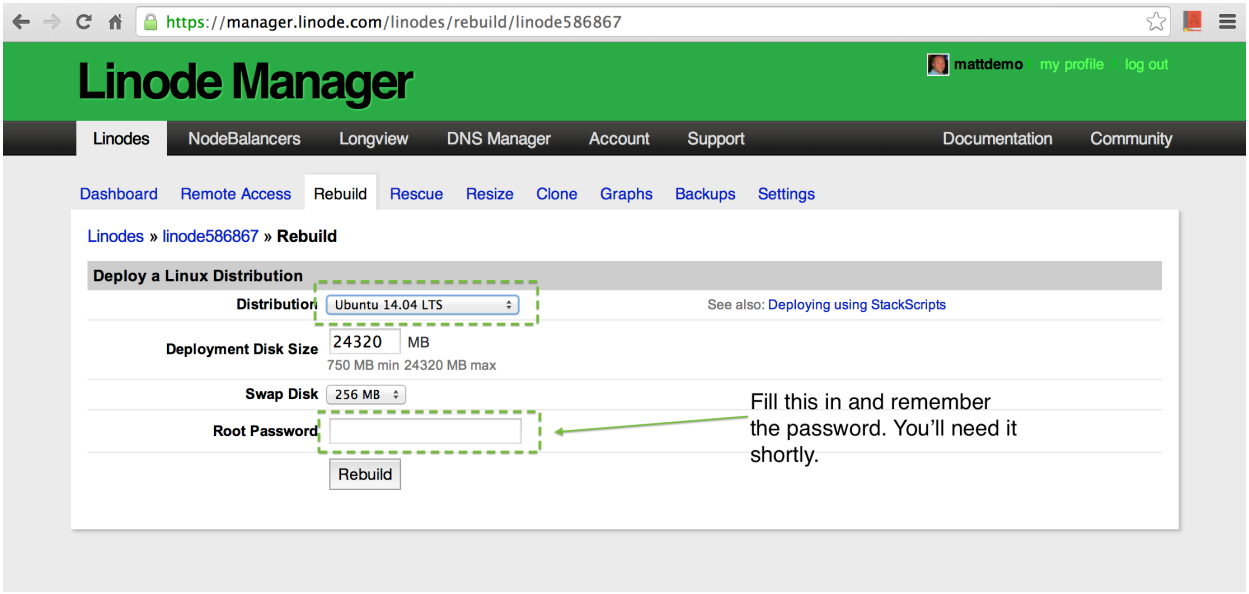


Our deployment will use Ubuntu 14.04. Ubuntu 14.04 is the current Long Term Support (LTS) release and has a 5 year support lifecycle. This version will receive security updates until April 2019 as shown on the Ubuntu wiki

page for LTS releases. A future update of this book will use 16.04 LTS once it is released and tested to ensure it is as stable as 14.04.



Select Ubuntu 14.04 LTS and enter a password. Make sure you type the password in carefully and remember it! We will need the password again in a few minutes to log in as our root user. The "Deployment Disk Size" and "Swap Disk" can be left as their default values.



When the build process begins Linode will send us back to our server's dashboard page. The progress bars will show the status and in a couple of minutes the server will be ready to boot up.

Don't start the server just yet. We need to create a public-private key pair that will be used to harden our new server against unauthorized login attempts.

Create Public and Private Keys

Before we boot up our newly-provisioned server we need to create a public-private key pair on our local machine. Then we can upload the locally-created public key to our remote server.

Once we are using the key pair we can disable password logins for greatly increased server security. In addition, we will not have to type in a password each time we want to log into the server via SSH, which is way more convenient.

If you already have an SSH key pair you want to use then feel free to skip on to the next section. However, if your existing key pair has a passphrase on it then you will want to follow these steps to create a new key pair. This book uses a passphrase-less key pair to perform the automated deployments as well as minimize the amount of typing needed during our manual deployment process.

On your local computer (not the server you created on Linode), open a new terminal window. Again, if you are on Windows you will need to set up VirtualBox with a Linux image to follow these commands.

Create a directory with the following commands to store our key pair. Remember that there is also a companion GitHub repository with all this code and tags for each chapter in case you do not want to type everything in yourself. However, even if you use the code in the repository you'll have to create your own public-private key pair with these steps since the key pair cannot be shared.

```
# the mkdir command with the -p argument will recursively
# create the directory and subdirectory
mkdir -p fsp-deployment-guide/ssh_keys

# 'cd' moves us into ssh_keys directory in our local shell
cd fsp-deployment-guide/ssh_keys
```

Throughout this book we will refer to the `fsp-deployment-guide` directory as the *base directory* for our deployment files.

Execute the following `ssh-keygen` command to create the public-private key pair.

```
# we're running ssh-keygen command to generate the key pair
# -b argument specifies the number of bits, 2048 in our case
# along with -t argument to specify the RSA algorithm
ssh-keygen -t rsa -b 2048
```

When prompted for a file in which to save the keys do not use the default. Instead, enter the following directory and file into the prompt.

```
# we are saving the private key in our local ssh_keys directory
./prod_key
```

Press enter twice when prompted for a passphrase. We will not use a passphrase for the deployer user's keys.

After entering a blank passphrase twice, the key pair is generated by the `ssh-keygen` program. Now you have two new files: a private key `prod_key` and a public key `prod_key.pub`. The private key should never be shared with anyone as it will allow access your server once it is configured. The public key can be shared with anyone and does not need to be kept private.

Execute the following command to copy the newly-created public key to a separate file that holds authorized keys.

```
# the authorized_keys file will allow our server to grant SSH
# access to a connection using the private key
cp prod_key.pub authorized_keys
```

You now have the required public and private key files as well as an `authorized_keys` file. Keep backups of these files in a safe place since once the server is locked down you'll need them to log in.

With our new key files we can now fire up the server and set up our security configuration.

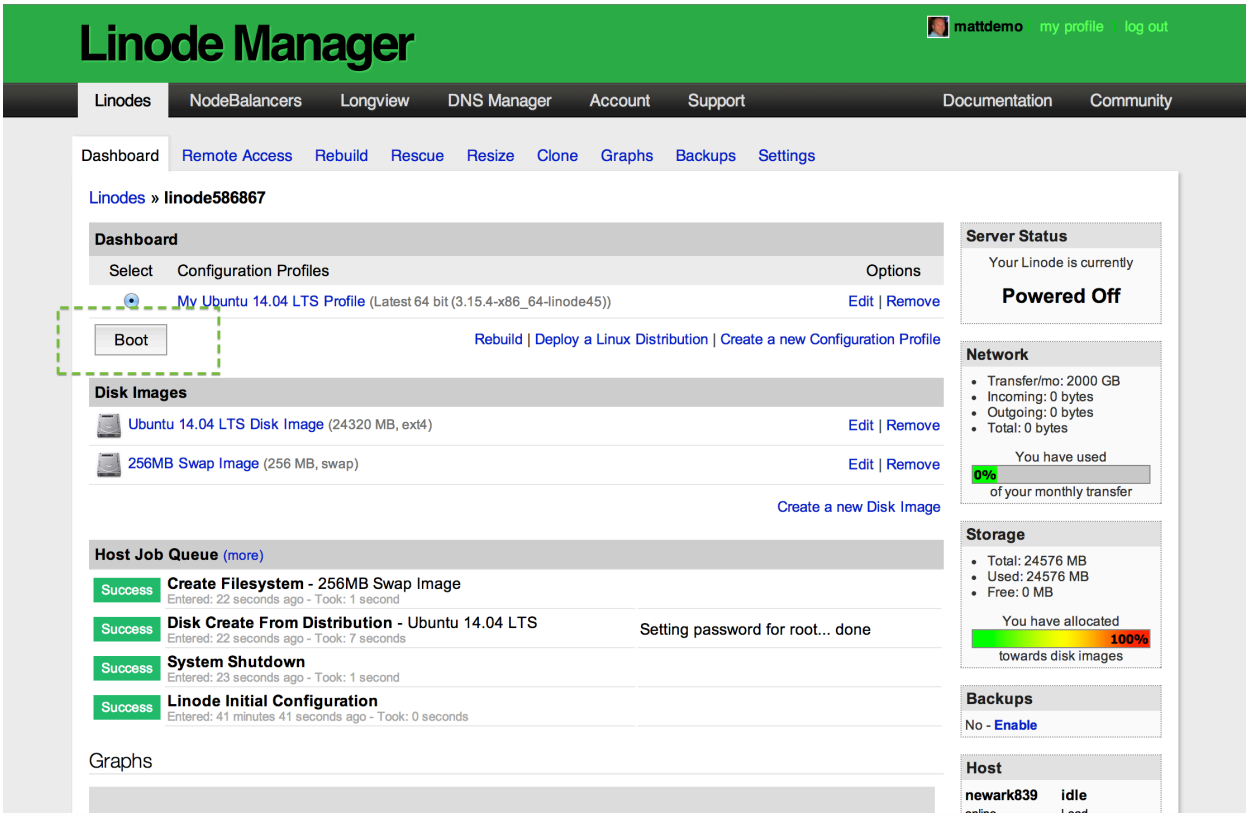
Boot and Secure the Server

When we boot up the server we need to ensure it is locked down against unauthorized access attempts. There are scores of malicious bots that search for servers across the IPv4 address range. The Internet is a dangerous place for unsecured servers.

Fortunately, with a few steps we can mitigate the most glaring security weaknesses of a newly-provisioned server.

When you are ready to begin the initial lock down steps we can start our machine up.

Click the "Boot" button and the Ubuntu boot process will get started. Booting should take less than a minute. Bring up your local command line as we will need it to connect to the remote machine.



SSH into your server with `ssh root@{ip.address.here}` where `{ip.address.here}` is your server's IP address, which can be found on the Linode dashboard. For example, if your new Linode's IP address is 66.175.209.129, you'll enter `ssh root@66.175.209.129`.

You'll likely receive a prompt like the following warning. This prompt states that you've never connected to this server before and it asks if you are sure that this host's signature matches the server on which you intend to connect. Enter `yes` then enter the root password you created during the earlier Linode server provisioning step.

```
The authenticity of host '66.175.209.192 (66.175.209.192)' can't be established.
RSA key fingerprint is 51:3c:ba:bc:c3:83:1a:36:b1:2d:e3:f6:6d:f0:11:56.
Are you sure you want to continue connecting (yes/no)? yes
```

A message like "Welcome to Ubuntu 14.04.4 LTS" will appear followed by a prompt. Now we can enter commands on the remote machine to get the server secured and setup.

Ensure the system packages cache is up to date.

```
# this command tells apt, Ubuntu's package manager, to make
# sure it has the latest list of package versions to install
apt-get update
```

Next upgrade all out of date packages.

```
# apt will upgrade older packages to the newest versions
# available in the packager manager
apt-get upgrade
```

Install `fail2ban` with its sensible default settings.

```
# fail2ban is a security package that logs unsuccessful logins
# and prevents brute force login attempts
apt-get install fail2ban
```

Next we need to modify the SSH configuration so a connection cannot directly log into the root user account. Only someone using the exact private key we created earlier can connect to this server.

Open the `/etc/ssh/sshd_config` file in the text editor of your choice. For example use `vim /etc/ssh/sshd_config` to open the file in Vim. You can also use the `nano` or `emacs` commands if you prefer them instead. You should see the following lines of the file in your editor.

Edit the following highlighted lines in the configuration file to match what is shown below.

```
# Package generated configuration file
# See the sshd_config(5) manpage for details

# What ports, IPs and protocols we listen for
Port 22

...

# Logging
SyslogFacility AUTH
LogLevel INFO
```

```
# Authentication:
LoginGraceTime 120
PermitRootLogin no
StrictModes yes

RSAAuthentication yes
PubkeyAuthentication yes
#AuthorizedKeysFile     %h/.ssh/authorized_keys

# Don't read the user's ~/.rhosts and ~/.shosts files
IgnoreRhosts yes
# For this to work you will also need host keys in /etc/ssh_known_hosts
RhostsRSAAuthentication no
# similar for protocol version 2
HostbasedAuthentication no
# Uncomment if you don't trust ~/.ssh/known_hosts for RhostsRSAAuthentication
#IgnoreUserKnownHosts yes

# To enable empty passwords, change to yes (NOT RECOMMENDED)
PermitEmptyPasswords no

# Change to yes to enable challenge-response passwords (beware issues with
# some PAM modules and threads)
ChallengeResponseAuthentication no

# Change to no to disable tunnelled clear text passwords
PasswordAuthentication no

...

# If you just want the PAM account and session checks to run without
# PAM authentication, then enable this but set PasswordAuthentication
# and ChallengeResponseAuthentication to 'no'.
UsePAM no
```

Above, you changed `PasswordAuthentication` to `no` because passwords are not necessary for logging in with the private key.

`UsePAM` is set to no because we are using a key pair so password authentication should be disabled for this server.

Set `no` for `#PermitRootLogin` so that we can lock down the `root` account and only access the server with a user account that will be created in a moment.

Save the file.

We need to create a non-root group before we can create a new non-root user to put into the non-root group. Execute the following commands on the remote server. You can change "deployers" to another group name if you want but you have to be consistent in future steps.

```
# create the new deployers group
/usr/sbin/groupadd deployers
```

```
# back up the sudoers file
mv /etc/sudoers /etc/sudoers-backup
# modify the sudo list so the deployers group has sudo privileges
(cat /etc/sudoers-backup ; echo "%deployers ALL=(ALL) ALL") > /etc/sudoers
# ensure the appropriate permissions are on the sudoers file
chmod 0440 /etc/sudoers
```

Now add a non-root user with the non-root group we just created. Replace the name `Matt Makai` with your name (but leave the quotes around the name). You will be prompted to enter the same new password twice for this account.

```
 # create the new user. be sure to use your own name here
 /usr/sbin/useradd -c "Matt Makai" -m -g deployers deployer
 # set up a password for the new user. you'll need the
 # password to run sudo commands
 /usr/bin/passwd deployer
```

Create a directory for the new deployer user to store our public and private keys.

```
# add the deployer user to the deployers group
/usr/sbin/usermod -a -G deployers deployer
# create a directory for the deployer's public key and
# authorized_keys file
mkdir /home/deployer/.ssh
# change the owner and group of the .ssh directory to deployer
# and deployers, respectively
chown -R deployer /home/deployer/.ssh
chgrp -R deployers /home/deployer/.ssh
```

Don't log out of root just yet. We need to upload the public and private keys for the deployer user so we can log in with that account.

Upload Public SSH Key

In order to authenticate with our new deployer user, we need to upload the `prod.pub` and `authorized_keys` files.

Keep the root SSH connection open. We'll need that in a minute.

Go back to the command prompt on your local machine where the SSH keys we created earlier in this chapter are stored.

Upload the public SSH key and `authorized_keys` files to our server for the new deployer user. Again, make sure to replace the IP address with your server's IP address.

```
# scp is the 'secure copy' command and will transfer the
# public key along with the authorized_keys file to the server
scp prod_key.pub authorized_keys deployer@{your.server.ip.address}:~/.ssh
```

When prompted by the `scp` command enter the deployer's password that was created in the previous section.

Restart SSH Service

We need to ensure that we can SSH into the new deployer user after we reload our SSH configuration on the remote server.

In the terminal where root is logged into your virtual private server, run the following command. **Do not yet log off of root**!

```
# applies new SSH configuration settings so we can test them
service ssh reload
```

Now try to SSH in with the new deployer user in the other terminal window. Again, replace the IP address in this command with the IP address of your server.

```
# connecting to our new user instead of the root user
ssh -i ./prod_key deployer@{your.server.ip.address}
```

If you get a command prompt on the server, success! We can now close out our root connection. You won't be able to log directly into root anymore, only into the deployer user. That's a really good thing because automated malicious bots often try to log into the root user with their attacks.

Automate Server Configuration

Clearly we don't want to have to manually type in all these steps every time we create a new VPS instance. Fortunately the Fabric library makes these instructions easy to automate. Let's take a look at a short script that runs every step we just performed above. Remember, there is a GitHub repo with the automated code in case you want to copy and paste the text or clone the repository.

On your local machine, create a new directory named `prod` under your project. `prod` will store files for handling deployments to our production server for our application.

Within prod create a new file named `fabfile.py` with the following contents.

```
from os import environ
from fabric.api import *
from fabric.context_managers import cd
from fabric.contrib.files import sed

"""
   Fabric file to upload public/private keys to remote servers
   and set up non-root users. Also prevents SSH-ing in with the
   root user. Fill in the following blank fields then run this
   Fabric script with "fab bootstrap".
"""

# run the bootstrap process as root before it is locked down
env.user = 'root'

# the remote server's root password
env.password = ''

# all IP address or hostnames of the servers you want to put
# your SSH keys and authorized_host files on, ex: 192.168.1.1
env.hosts = ['192.168.1.1']

# your full name for the new non-root user
env.new_user_full_name = 'Matt Makai' # ex: Matt Makai

# username for the new non-root user to be created
env.new_user = 'deployer' # ex: deployer

# group name for the new non-root user to be created
env.new_user_grp = 'deployers' # ex: deployers

# local filesystem directory where your prod_key.pub and
# authorized_keys files are located (they will be scp'd
# to target hosts) don't include a trailing slash
# note: the tilde resolves to your home directory
env.ssh_key_dir = '~/fsp-deployment-guide/ssh_keys'

"""
   The following functions should not need to be modified to
   complete the bootstrap process.
"""
def bootstrap():
    local('ssh-keygen -R %s' % env.host_string)
    sed('/etc/ssh/sshd_config', '^UsePAM yes', 'UsePAM no')
    sed('/etc/ssh/sshd_config', '^PermitRootLogin yes', 'PermitRootLogin no')
    sed('/etc/ssh/sshd_config', '^#PasswordAuthentication yes',
        'PasswordAuthentication no')
    _create_privileged_group()
    _create_privileged_user()
    _upload_keys(env.new_user)
    run('service ssh reload')

def _create_privileged_group():
    run('/usr/sbin/groupadd ' + env.new_user_grp)
    run('mv /etc/sudoers /etc/sudoers-backup')
    run('(cat /etc/sudoers-backup ; echo "%' + env.new_user_grp \
        + ' ALL=(ALL) ALL") > /etc/sudoers')
    run('chmod 440 /etc/sudoers')

def _create_privileged_user():
```

```
    run('/usr/sbin/useradd -c "%s" -m -g %s %s' % \
        (env.new_user_full_name, env.new_user_grp, env.new_user))
    run('/usr/bin/passwd %s' % env.new_user)
    run('/usr/sbin/usermod -a -G ' + env.new_user_grp + ' ' + \
        env.new_user)
    run('mkdir /home/%s/.ssh' % env.new_user)
    run('chown -R %s /home/%s/.ssh' % (env.new_user,
     env.new_user))
    run('chgrp -R %s /home/%s/.ssh' % (env.new_user_grp,
        env.new_user))

def _upload_keys(username):
    local('scp ' + env.ssh_key_dir + \
          '/prod_key.pub ' + env.ssh_key_dir + \
          '/authorized_keys ' + \
          username + '@' + env.host_string + ':~/.ssh')
```

Within `fabfile.py`, edit the line that begins with `env.password` so it has your root password entered while creating your Linode server.

```
# this is the root password you created with the Linode server
env.password = 'New root password here'
```

Next edit the line that begins with `env.hosts` so it has your VPS' IP address. The IP address can be found on the your Linode account dashboard.

```
# this IP address can be found on the Linode Manager Linodes list
env.hosts = ['192.168.1.1']
```

Modify line 24 with your full name for the non-root user.

Change the value under `env.ssh_key_dir = '~/fsp-deployment-guide/ssh_keys'` to the directory where you created your `prod_key` and `prod_key.pub` files.

Run Fabric Script

Fabric relies on Python having the `Fabric` library installed. We'll use virtualenv, a Python tool for isolating packages, to create a separate Python installation that keeps our Fabric package dependency separate from other existing Python packages.

Note that we will have to use Python 2 for now because unfortunately Fabric and Ansible (which we will starting using in the next chapter) do not yet support Python 3.

Create a virtualenv with the following commands. This virtualenv will hold our Python application dependencies. If you already have a directory where

you keep your virtualenvs, you can skip the first step and place your new virtualenv in that existing directory.

```
mkdir ~/Envs/
virtualenv -p python2.7 ~/Envs/fspdeploy
source ~/Envs/fspdeploy/bin/activate
```

When you enter the last of those commands your prompt will change to look something like the following line, which means we've activated the virtualenv in our current shell:

```
(fspdeploy)$
```

If we try to use the `fabric` command right now, it will fail with the following error message.

```
-bash: fabric: command not found
```

We need to install Fabric into the virtualenv. Use the following pip command to install Fabric:

```
pip install fabric==1.10.2
```

Make sure you have plugged in your server settings at the top of the Fabric file as specified in the previous section. Execute the script from the local command line with `fab bootstrap`. You'll be prompted for a password for the new user and then the script will connect to the server again with that user to complete the steps we walked through manually earlier this chapter.

Note that this script does not install fail2ban like we did in the manual steps above. Our Ansible playbook that we'll create in the next chapter will handle installing fail2ban and other apt packages for us.

Next: Operating System

We have secured our server against brute-force password attacks on the root account plus some basic precautions with a public-private key pair. These initial basic security settings are a decent start over the default server configuration.

In the next chapter we will establish the operating system configuration for running Python web applications. We will also introduce Ansible which will provide the rest of the automation necessary for the deployment.

More Server Resources

Numerous additional resources exist if you are not yet entirely comfortable with the steps we performed in this chapter. Be sure to take a look at the following links for learning reinforcement on initial server setup.

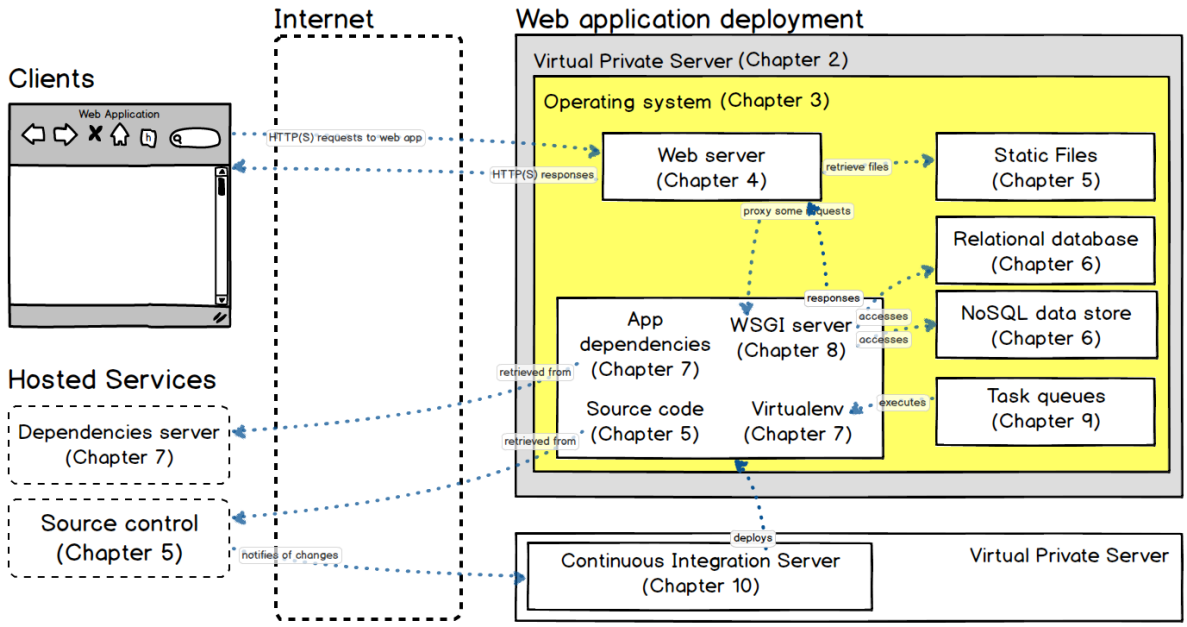
- See the deployment and servers pages on Full Stack Python for a slew of additional resources and explanations on these topics.
- Choosing a low cost VPS reviews the factors that you should weigh when deciding on hosting providers.
- First 5 Minutes on a Server explains what steps are necessary for a basic security profile on a new server.
- The cloud versus dedicated servers is a few years old but explains the differences between several hosting platforms compared with having a dedicated server or virtual private server.

Chapter 3

Operating Systems

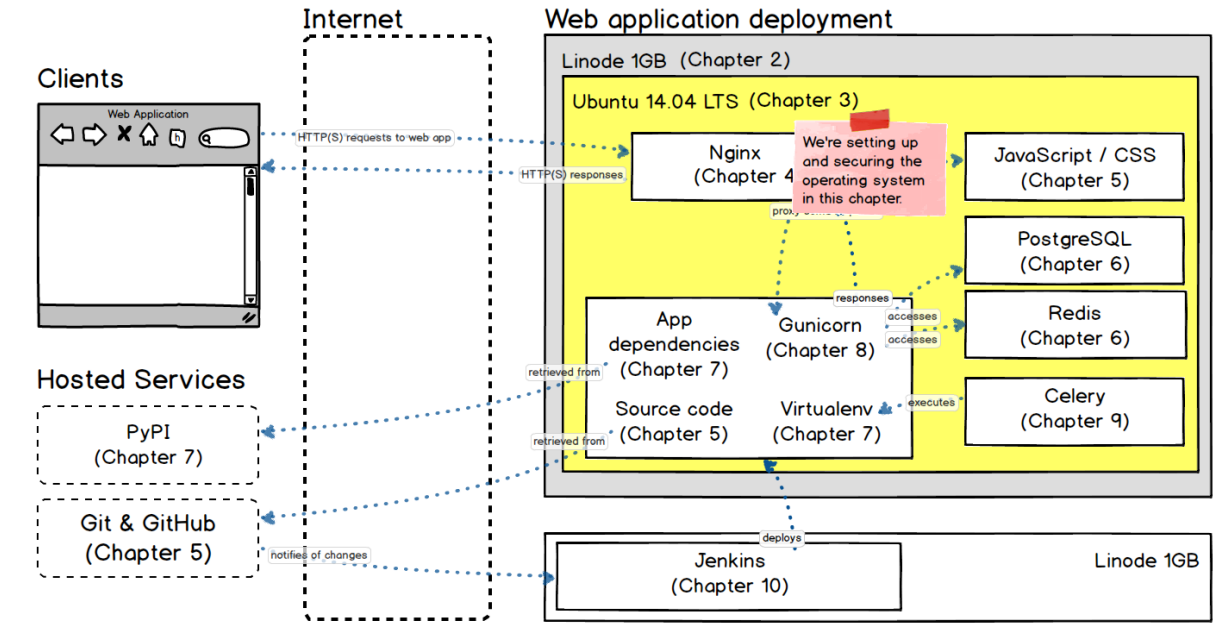
Operating Systems

An operating system runs on a server and controls access to computing resources that our web application will use to run.



An operating system makes many of the computing tasks we take for granted easy. For example, the operating system enables writing to files, communicating over a network and running multiple programs at once. Otherwise you'd need to control the CPU, memory, network, graphics card and many other components with your own low-level implementation.

In this chapter we set up and configure our operating system, Ubuntu Linux 14.04 Long Term Support (LTS), on our Linode virtual private server.



Ubuntu includes a package manager for installing necessary system libraries that we need to run our Python web application. We will also lock down the operating system against unauthorized access attempts.

Ubuntu

Ubuntu is a Linux distribution packaged by the Canonical Ltd company. For desktop versions of Ubuntu, GNOME (until the 11.04 release) or Unity (11.10 through current) is bundled with the distribution to provide a user interface.

Ubuntu Long Term Support (LTS) releases are the recommended versions to use for deployments. LTS versions receive five years of post-release updates from Canonical. Every two years, Canonical creates a new LTS release, which allows for an easy upgrade path as well as flexibility in skipping every other LTS release if necessary. As of March 2016, 14.04 Trusty Tahr is the latest LTS release.

Mac OS X, and to a lesser extent Windows, are fine for developing your Python application. However, Windows and Mac OS X are not appropriate for our production deployment.

Install System Packages

Ubuntu uses the Debian distribution as a base for packages, including the apt package manager. There are several required apt packages found on Linux servers running a Python stack. These packages are:

- python-dev for header files and static libraries for Python development
- python-virtualenv for creating and managing Python virtualenvs to isolate library dependencies
- git-core for the Git version control system
- nginx is a web server that will answer our incoming HTTP requests
- supervisor controls the state of our WSGI server and task queue

Let's install these packages needed for our deployment.

Ensure the package manager's local cache is up to date. We performed this in the previous chapter to properly install `fail2ban` but it is always a good practice to update just before installing new packages.

```
$ sudo apt-get update
```

Install the required packages for our Python web application deployment.

```
$ sudo apt-get install fail2ban python-virtualenv python-dev
```

It will take a little while for the packages to get installed since apt is downloading everything from the central Ubuntu package repositories.

When it's done you'll see something like the following line and you will be back at the command prompt.

```
Processing triggers for libc-bin (2.19-0ubuntu6) ...
```

With these packages in place we now have the basic system dependencies to get our Python environment running. However, our system still needs a firewall to lock down ports other than 22 (ssh), 80 (HTTP) and 443 (HTTPS).

Enable Firewall

Ubuntu has a handy tool named Uncomplicated Firewall (`ufw`). Run these commands with `ufw` on our server to stop Internet traffic against ports we do not intend to expose to the outside world.

```
ufw allow 22
ufw allow 80
ufw allow 443
```

The first three above commands tell our operating system to only allow incoming network connections to go through to ports 22, 80 and 443. We now need to enable the firewall with the following command:

```
ufw enable
```

Our firewall is in place, but it was a pain to manually run all the above commands. Next we will take a look at the configuration management tool Ansible, which helps us automate our deployment process.

Ansible

Ansible is an open source configuration management tool written in Python that will allow us to automate the steps in this chapter we previously performed manually. Throughout the book we will also build on the Ansible scripts, which are called "playbooks" in Ansible terminology, in each subsequent chapter.

Ansible has hundreds of built-in modules to execute tasks for setting up and running servers. The source code for every module is freely available on Ansible's core and extras Git repositories.

Time to write the structure for the Ansible playbook which will be filled in throughout each chapter's automation sections. If you want to skip typing these instructions in there is an open source Git repository that is tagged with steps for each chapter.

In the last chapter we created a `prod` directory for our `fabfile.py` Fabric script. Now we can add our Ansible files within the same directory. This can either be under your project or a separate source control repository. Remember to keep your confidential information such as usernames and passwords private!

```
cd prod
touch deploy.yml hosts
mkdir roles group_vars
```

We just created a new file for the main YAML playbook named `deploy.yml`, which will coordinate our deployment's various roles. We also created a hosts file that will tell Ansible what server IP addresses to deploy our application.

Fill in the `prod/deploy.yml` file with the following text.

```
###
# This playbook deploys the whole application stack in this site.
##
- name: apply common configuration to server
  hosts: all
  user: deployer
  roles:
    - common
```

1. Fill in the hosts file with the following text. Replace `192.168.1.1` with your Linode server's IP address.

```
[common]
192.168.1.1
```

Next create directories to hold the Ansible role files that will contain the instructions for Ansible to execute.

```
mkdir -p roles/common/tasks
cd roles
mkdir -p common/handlers common/templates
```

We need to set variables to complete the roles. The variables won't be used until we fill out roles that have the variable tokens in them.

```
touch group_vars/all
```

Create a file named `group_vars/all` with the following YAML. This is the start of our variables file. It initially contains 4 variables that are specified as key-value pairs. For example, our `app_name` variable key that can be accessed throughout our Ansible playbook has the value of `cyoa`. If we deploy a different application we can change the `app_name` value to another value. For example, in the Ansible playbook for my Programming Languages API project the value for the `app_name` key is `plapi`.

```
# Chapter 3: Operating System (Ubuntu)
app_name: cyoa
deploy_user: deployer
deploy_group: deployers
## this is the local directory with the SSH keys and known_hosts
## file do not include a trailing slash
ssh_dir: ~/fsp-deployment-guide/ssh_keys
```

With our variables in place we can automate the first steps of our deployment. Create a file named `prod/roles/common/tasks/main.yml` and insert the following YAML. These four lines are just 3 lines of comments and an `include` statement, which will reference the next file that we should create in the next step.

```
###
# configures the server and installs the web application
##
- include: ubuntu.yml
```

Create a file named `roles/common/tasks/ubuntu.yml` Make sure the file is created in the same directory as the `main.yml` file. Insert the following YAML lines that instruct Ansible to update our apt cache, install three system packages and set up the firewall.

```
##
# updates the APT package cache and install packages
# servers necessary for web. also enables firewall
##
- apt: update_cache=yes
  sudo: yes

- name: ensure web server packages are installed
  apt: name={{item}}
  sudo: yes
  with_items:
    - fail2ban
    - python-virtualenv
    - python-dev

- name: enable SSH in firewall
  ufw: rule=allow port=22
  sudo: yes
- name: enable HTTP connections for web server
  ufw: rule=allow port=80
  sudo: yes
- name: enable HTTPS connections for web server
  ufw: rule=allow port=443
  sudo: yes
- name: enable firewall
  ufw: state=enabled
  sudo: yes
```

That's the initial playbook. Now to run Ansible we have to install it into our Python site-packages directory within a virtualenv. You should be familiar

with virtualenvs from developing your application and setting it up in the previous chapter but if you need a refresher go ahead and brush up with this great tutorial.

If your virtualenv is not yet activated, do that first with the following command. Use the same virtualenv we created in the previous chapter.

```
source ~/Envs/fspdeploy/bin/activate
```

Use the following pip command to install the Ansible 1.9.2 release. Newer releases such as 2.0 should work fine with most of the code, but this book will be updated after testing all sections with each Ansible release.

```
pip install ansible==1.9.2
```

To run the playbook I recommend creating a shell script named `deploy_prod.sh` in the base directory of our project with the following contents. This way you can just use this shell script instead of typing out the entire line with arguments each time you need to run the playbook.

```
#!/bin/bash
ansible-playbook ./prod/deploy.yml --private-key=\
./ssh_keys/prod_key -K -u deployer -i ./prod/hosts
```

Be sure to set the appropriate permissions on the `deploy_prod.sh` file.

```
chmod 0744 deploy_prod.sh
```

Now we can invoke that file by running it on the command line as follows.

```
./deploy_prod.sh
```

You will be asked for the sudo password once to kick things off then this playbook will automate the manual steps from this chapter and the previous one.

Next: Web Server

We will continue building our Ansible playbook out in the following chapters. In the next chapter on web servers we can configure the Nginx web server which was just installed through a system package.

More OS and Ansible Resources

The following resources, along with the ones listed on the operating systems and configuration managemenet pages, are a good place to continue learning about the topics presented in this chapter.

Operating System Resources

The following references provide greater insight into Linux distributions and how to deploy on Ubuntu.

- Lifehacker's guide to choosing a Linux distro has additional information about Ubuntu compared with other Linux distributions.
- Digital Ocean has a detailed walkthrough on setting up Python web applications specifically for Ubuntu.
- It's important to become comfortable with the basics of working on a Linux operating system, so this curated list of Linux basics can be really beneficial if you haven't previously used Linux.

Ansible Resources

Ansible is a powerful configuration management tool. Once you get over the initial YAML-learning hump, it is way easier to deploy an entire application stack than manually or with shell scripts. The following resources will help you get more comfortable with using Ansible.

- Ansible vs. Shell Scripts provides some perspective on why using a configuration management tool is a better choice than venerable but brittle shell scripts.
- The official Ansible documentation is a good first link to read for quickstarts, modules reference and how Ansible works under the covers.
- Getting Started with Ansible is a wonderfully detailed introduction to using Ansible for configuring servers.
- First Five (and a half) Minutes on a Server with Ansible is similar to the first five minutes on a server post listed in the previous chapter and it shows how to automate those initial steps using Ansible.

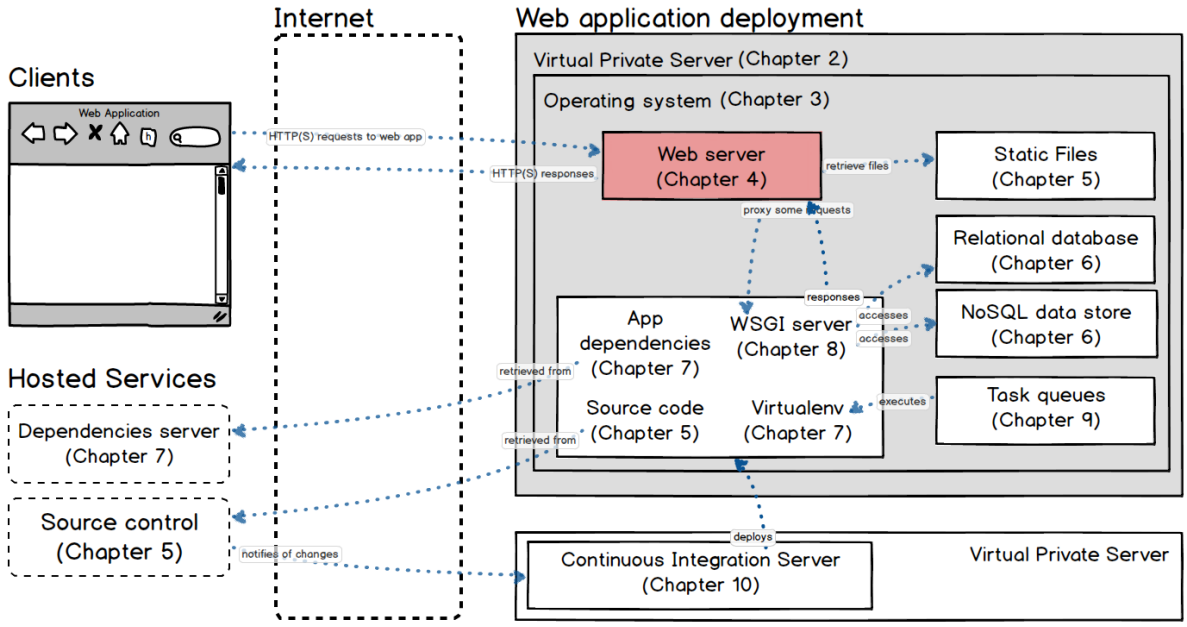
- Ansible Text Message Notifications with Twilio SMS is a blog post I wrote with a starter example for using the Twilio module included with Ansible 1.6+.

Chapter 4

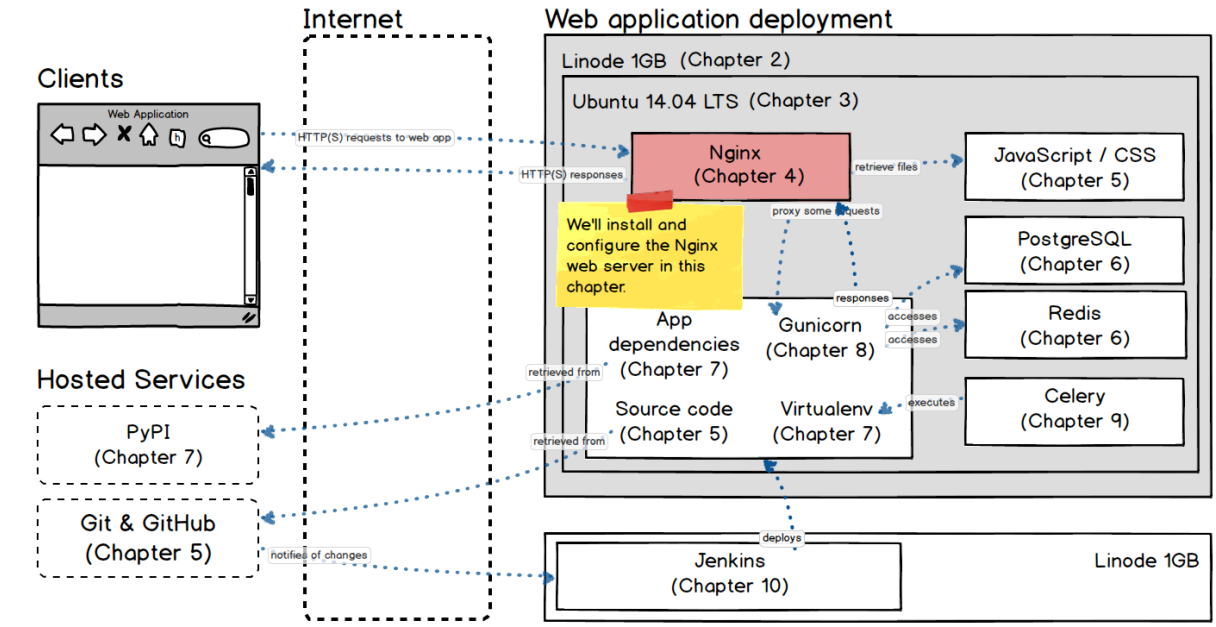
Web Servers

Web Servers

Web servers respond to Hypertext Transfer Protocol (HTTP) requests from clients and send back a response containing a status code and content such as HTML, XML or JSON. In our deployment, the web server handles serving up static files such as our CSS and JavaScript files, while also proxying requests to and from the WSGI server.



Our deployment will use the web server Nginx (pronounced "Engine-X") throughout our deployment.



Nginx is used by a large percentage of the top websites on the Internet. The server's configuration files are generally considered easier to read and write than the config files for the Apache HTTP server, which is the most commonly used web server on the Internet.

Nginx

In our deployment, the web server Nginx will perform two jobs:

1. Handle requests for static files and respond with appropriate files
2. Reverse proxy requests and responses to and from our WSGI server

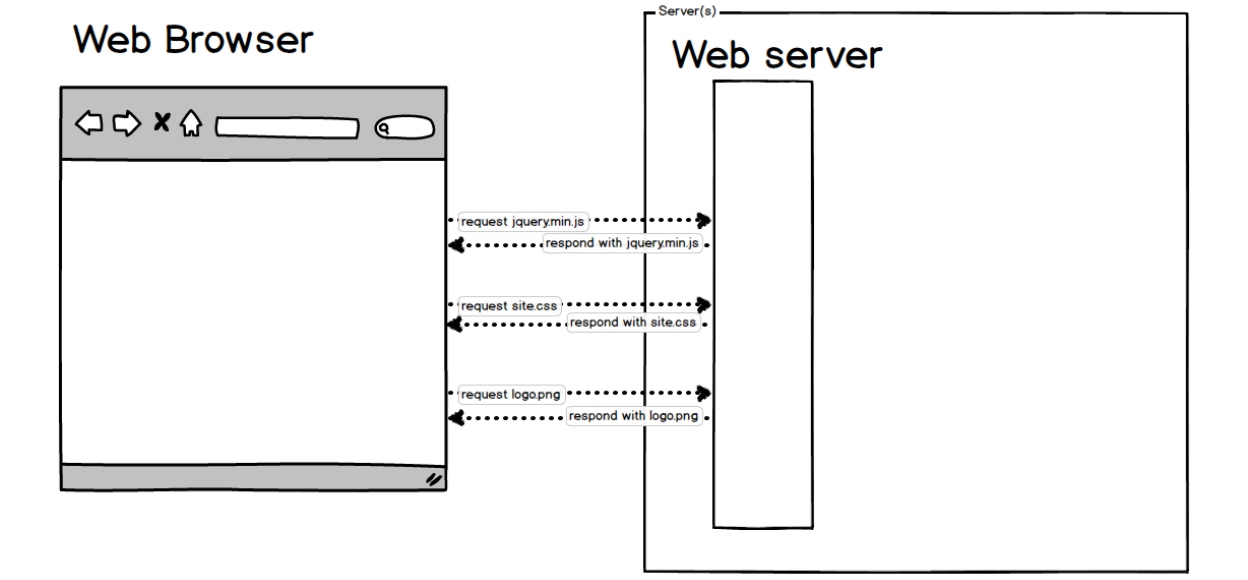
In the first use case our Nginx web server directly handles requests for static files by responding with appropriate files from the `static/` directory. In the `static/` directory there will be subfolders for various static file types such as JavaScript, CSS and images.

For the second use case the web server be a reverse proxy to pass through requests to our WSGI server so it can run our Python code to craft the response. A reverse proxy is simply a middleman that accepts an incoming HTTP request and passes it along to the WSGI server so it can process the request and issue a response that's been created by an upstream server.

Visualizing Nginx's Purpose

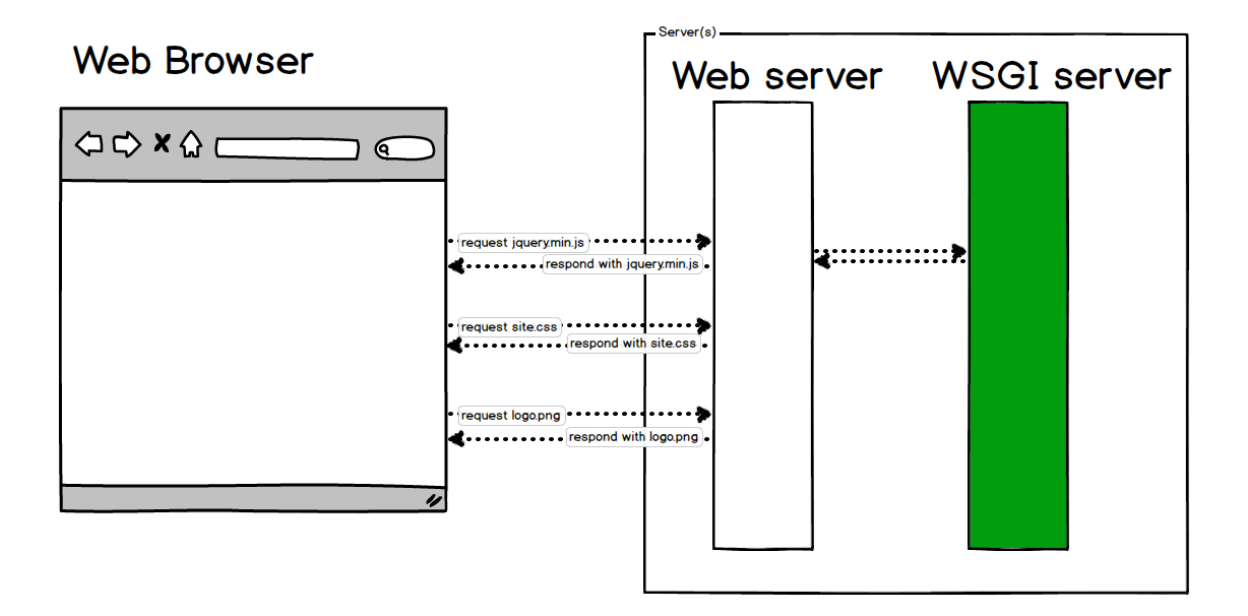
Our deployment will use the Nginx web server, the second most commonly used web server after Apache. Nginx is used at the largest scale by many organizations on the web so you won't have to worry about swapping it out later for another web server.

Let's take a look at how our web server Nginx works as both a web server and a reverse proxy.



The web server sends files to a web browser based on browser requests. In the first request, the browser asked for the file `query.min.js` and the server responded with the JavaScript file. The web browser then accessed `site.css` and `logo.png` and again the server responded with those static files.

However, not all requests are for static files. For example, a page from our web application must be generated by the WSGI server running our Python code. That scenario is shown in the following image.



In this case the web server is configured to pass requests for non-static files to the WSGI server. We will lay the groundwork for that configuration in this chapter and complete it later in the WSGI server chapter.

Before we install and configure Nginx on our server we'll need to perform two steps: set a domain name to point to our server and (optionally) create an SSL certificate. We'll first set up the domain name then give you the choice to create an SSL certificate to provide an HTTPS connection or just use plain old HTTP to serve the application.

Install Nginx

We need to use the system package manager to install Nginx just as we did with `fail2ban` and our Python packages.

Install the `nginx` package via apt on our remote machine.

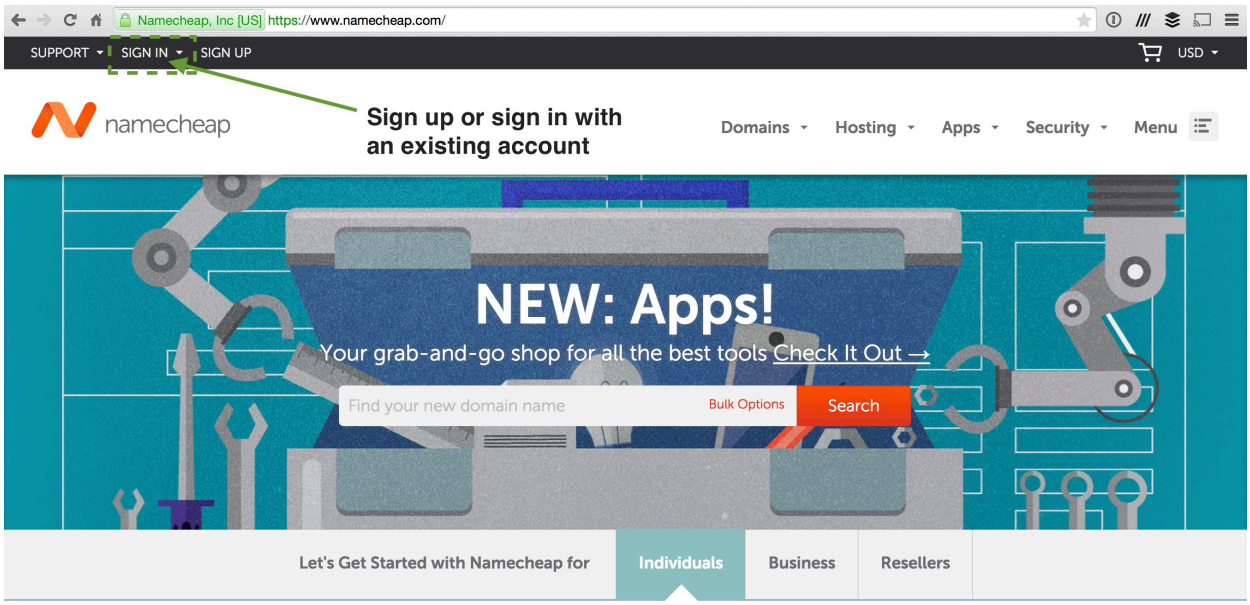
```
sudo apt-get install nginx
```

Next we need to set up our domain name so we can access the app from a URL instead of the IP address. In our deployment we'll use Namecheap to handle the domain name server resolution.

Domain Name Service Resolution

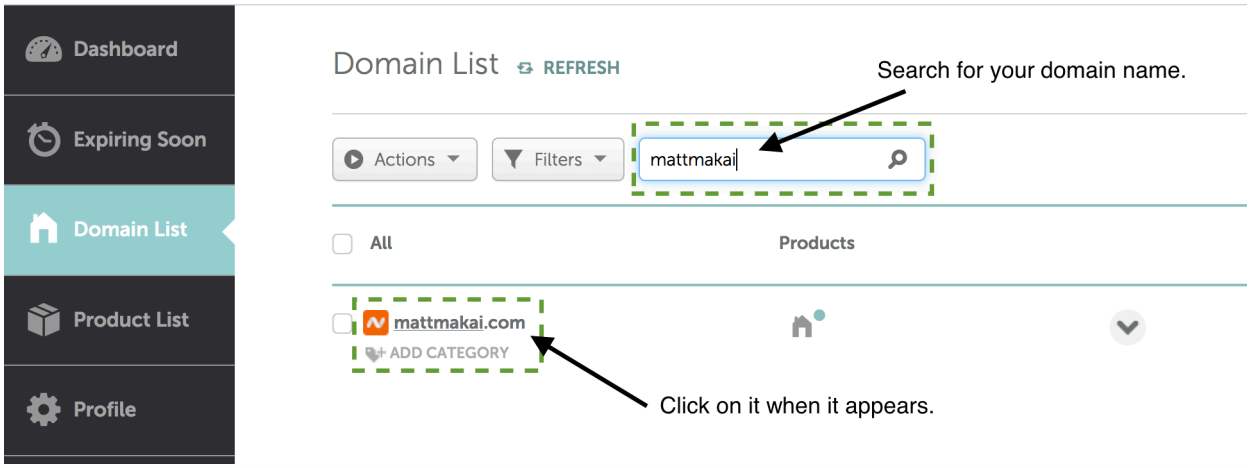
For our application we do not want to users to have to enter an IP address into their web browser. Instead, we want a domain name so we can access our application through a normal looking URL. In this case, we'll see how to use a domain name registered with Namecheap to point our application to `cyoa.mattmakai.com`.

Go to https://www.namecheap.com/ in your browser on your local machine. Sign up for an account or sign in to your existing account.

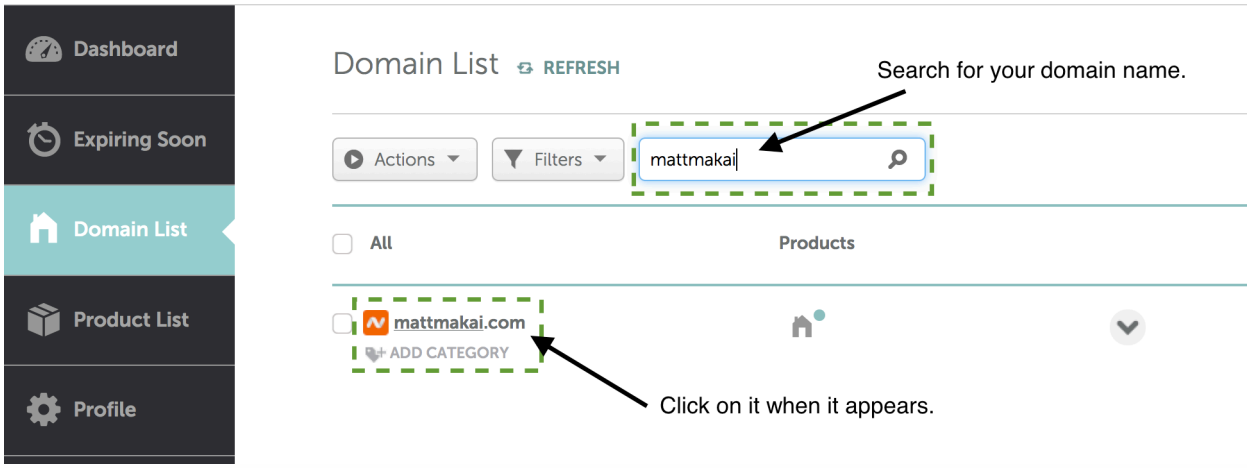


Create your pro web presence in no time.

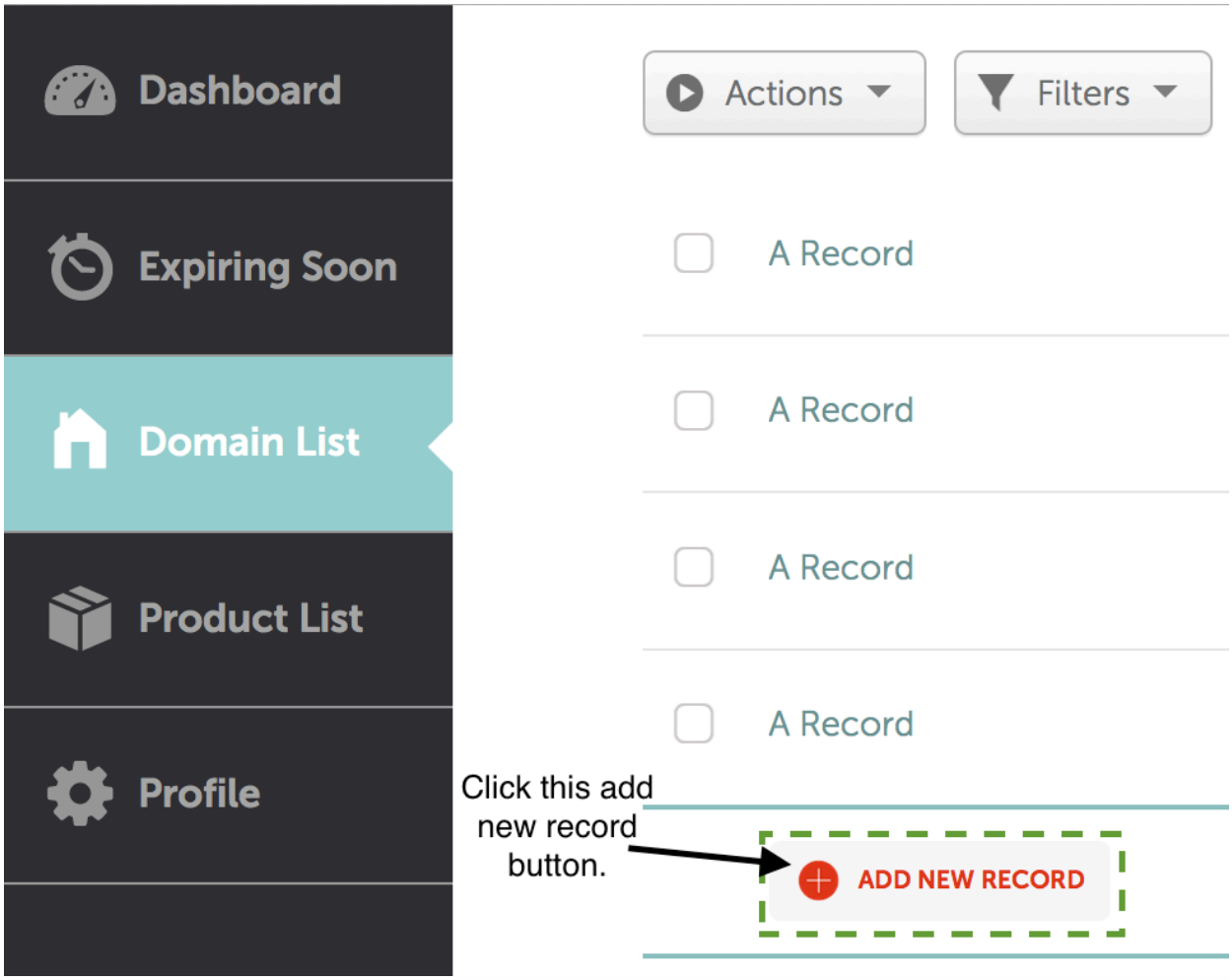
Once you've signed in, go to your domain list.



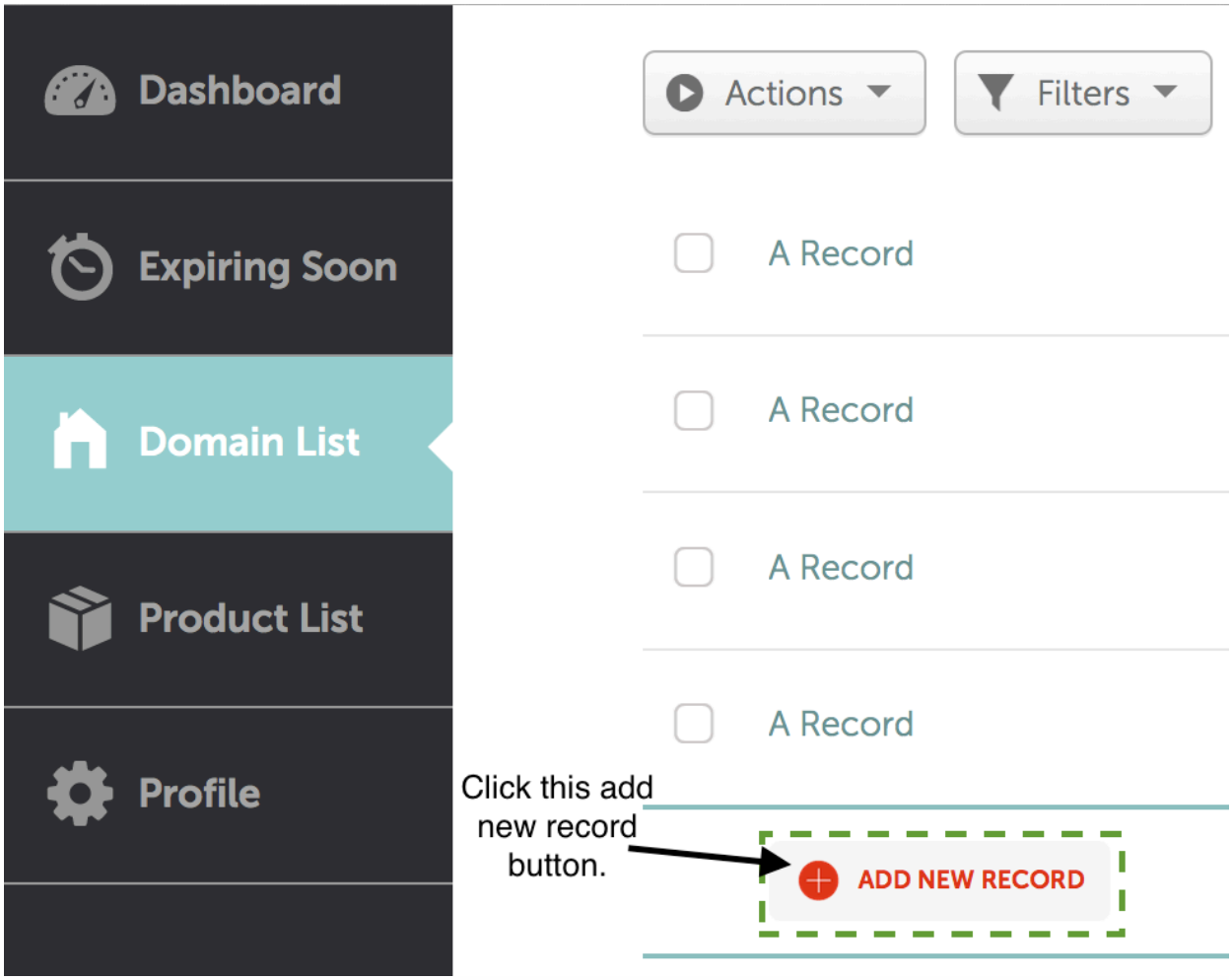
Search for, then select the domain name you want to set up for this application. If you do not yet have a domain that you want to use, first register one.



Click "Advanced DNS".



Press the "Add New Record" button.



There are two options for your configuration. If you want the standard `www` in your URL, set `www` with your server's IP address and specify the record as A (Address). If instead you want a different subdomain, such as `cyoa` as I show in the screenshot here, then enter the subdomain with the server's IP address and select the A (Address) record in the dropdown.

Save the new settings. It may take a few minutes to take effect as the data must be propagated to many Domain Name System hosts.

Now we can configure Nginx to either use HTTP or HTTPS. Both options are included in this chapter. If you just want to deploy without encryption provided by HTTPS, read the next section. However, your application will not be secure. If you want security and encryption provided by the latest version of SSL/TLS then skip down to "Configure Nginx with HTTPS".

Nginx Without HTTPS

In this section we configure Nginx without HTTPS provided by SSL/TLS. If you want your application to use encryption (and it should!), skip this section and move onto the next one. This section is for readers who want to get up and running as quickly as possible or don't care about using encryption while testing their application deployment.

On the production server create a configuration file under `/etc/nginx/conf.d/` with your app name plus the `.conf` extension. In the default case we will use the `cyoa.conf` filename, so the full path and filename will be `/etc/nginx/conf.d/cyoa.conf`. Note that we need to use sudo privileges to create and save the file within Nginx's configuration directory. Add the following lines to this new configuration file.

```
upstream app_server_wsgiapp {
  server localhost:8000 fail_timeout=0;
}

server {
  listen 80;
  # make sure to change the next line to your own domain name!
  server_name cyoa.mattmakai.com;
  access_log            /var/log/nginx/cyoa.access.log;
  error_log             /var/log/nginx/cyoa.error.log info;
  keepalive_timeout     5;

  # nginx serve up static files and never send to the WSGI server
  location /static {
    autoindex on;
    alias /home/deployer/cyoa/static;
  }

  location / {
    proxy_set_header X-Forwarded-For $proxy_add_x_forwarded_for;
    proxy_set_header Host $http_host;
    proxy_redirect off;
    if (!-f $request_filename) {
      proxy_pass http://app_server_wsgiapp;
      break;
    }
  }

  # this section allows Nginx to reverse proxy for websockets
  location /socket.io {
    proxy_pass http://app_server_wsgiapp/socket.io;
    proxy_redirect off;
    proxy_buffering off;

    proxy_set_header Host $host;
    proxy_set_header X-Real-IP $remote_addr;
    proxy_set_header X-Forwarded-For $proxy_add_x_forwarded_for;

    proxy_http_version 1.1;
    proxy_set_header Upgrade $http_upgrade;
    proxy_set_header Connection "Upgrade";
```

```
  }
}
```

That is all the configuration we need for now to have Nginx serve static files and provide a reverse proxy to the WSGI application over HTTP without encryption. If you do not want to try out encryption then skip ahead to the "Restart Nginx With New Configuration" section to make this configuration take effect.

Create SSL Certificate

We have to create an SSL certificate before we set up Nginx on our remote server with HTTPS. The certificates will get uploaded manually and then we will modify the Ansible playbook to handle the step in the future.

Next we create a self-signed certificate. That means this certificate will give a warning on most browsers if you access the web application because the certificate has not been blessed by a central certificate authority. I recommend buying a certificate from a Certificate Authority (CA) such as Digicert or StartSSL once you're ready to go live. Replace the self-signed certificate with the certificate from a valid CA and those browser warnings will go away.

If you have trouble with the following steps be sure to read this detailed guide on creating a self-signed certificate.

Execute the following commands on your local machine. You'll need OpenSSL installed which is part of Mac OS X and most Linux distributions.

Create a subdirectory from our base directory to hold our SSL/TLS certificate files as we generate them.

```
mkdir ssl_cert
cd ssl_cert
```

Generate a private key file using the `openssl` command as follows.

```
# write a private key file using a 4096 bit key
openssl genrsa -des3 -out ssl.key 4096
```

`ssh-keygen` will output to you that an RSA private key is being generated. Then you will be prompted for a passphrase as shown below. Enter a passphrase.

```
# enter a pass phrase between 8-16 characters
Enter pass phrase for ssl.key:
# verify the pass phrase by entering it again
Verifying - Enter pass phrase for ssl.key:
```

Now you have an `ssl.key` file in the current directory. Next we need to generate a certificate signing request (CSR).

```
# openssl allows us to create a signing request file
openssl req -new -key ssl.key -out ssl.csr
```

Fill in the information to the questions with your information. My example information is shown below. Not all questions need to be answered. Some of the questions, such as "Organizational Unit Name" can simply be left blank.

```
Enter pass phrase for ssl.key:
You are about to be asked to enter information that will be incorporated
into your certificate request.
What you are about to enter is what is called a Distinguished Name or a DN.
There are quite a few fields but you can leave some blank
For some fields there will be a default value,
If you enter '.', the field will be left blank.
-----
Country Name (2 letter code) [AU]:US
State or Province Name (full name) [Some-State]:California
Locality Name (eg, city) []:San Francisco
Organization Name (eg, company) [Internet Widgits Pty Ltd]:Full Stack Python
Organizational Unit Name (eg, section) []:
Common Name (e.g. server FQDN or YOUR name) []:www.fullstackpython.com
Email Address []:matthew.makai@gmail.com

Please enter the following 'extra' attributes
to be sent with your certificate request
A challenge password []:
An optional company name []:
```

Remove the passphrase from the key file because it's a pain when using automation to start and stop the web server as the passphrase would need to be entered for all operations.

```
# recreate the key file but without the pass phrase
openssl rsa -in ssl.key -out cyoa.key
```

There is no passphrase on `cyoa.key` and now we can finally generate the self-signed certificate file.

```
# this ssl.crt is the file we actually care about. it'll have a
# lifetime of 730 days (about 2 years)
openssl x509 -req -days 730 -in ssl.csr -signkey cyoa.key -out cyoa.crt
```

In the next section we will upload the new `cyoa.key` and `cyoa.crt` files to the server.

Install SSL Certificates

Nginx was already installed on our server in chapter two when we executed `apt-get install nginx`. Now we need to configure it to serve up static files and pass requests to the WSGI server that we will set up later.

Log back into your remote server. Create a directory to store the SSL certs temporarily on thed remote server.

```
mkdir /home/deployer/ssl_tmp/
```

Run the following command from your local machine from within the `ssl_cert` directory you previously created. From our local machine we need to copy in the SSL keys we just generated. Within the directory that stores the SSL key files, run the following commands to get them securely copied to the server. Remember to use the IP address of your server instead of the one shown in this command.

```
scp -i ../ssh_keys/prod_key cyoa.key cyoa.crt \
deployer@{your.server.ip.address}:/home/deployer/ssl_tmp/
```

Perform the following commands on the deployment server. Nginx's configuration can only be changed with root privileges so with the deploy user first execute this command to ensure the rest of these steps are performed with superuser privileges.

```
# -i argument allows us to interactively use multiple sudo commands
sudo -i
```

Change into the Nginx configuration directory.

```
cd /etc/nginx/
```

Create an SSL directory for our Nginx web app.

```
mkdir /etc/nginx/cyoa
```

Copy the SSL certificate files from the home directory.

```
cp /home/deployer/ssl_tmp/* /etc/nginx/cyoa/
```

Delete the SSL certificates from the home directory.

```
rm -rf /home/deployer/ssl_tmp/
```

We now need to set up Nginx's configuration so that it uses the SSL certificates. We'll also prepare it for passing requests to the WSGI server that will be set up in a later chapter.

Configure Nginx with HTTPS

It is time to configure Nginx using a custom configuration file, this time for encrypted connections. This configuration file will be set up to respond to HTTP requests via SSL connections.

Create a configuration file under `/etc/nginx/conf.d/` with your app name and `.conf` extension. In this case we'll deploy with the `cyoa.conf` filename, so the full path and filename will be `/etc/nginx/conf.d/cyoa.conf`. Note that we'll need to use sudo privileges to create and save the file within Nginx's configuration directory. Add the following lines to the file.

```
upstream app_server_wsgiapp {
     server localhost:8000 fail_timeout=0;
}

server {
 listen 80;
 # make sure to change the next line to your own domain name!
 server_name cyoa.mattmakai.com;
 rewrite ^(.*) https://$server_name$1 permanent;
}

server {
  # make sure to change the next line to your own domain name!
  server_name           cyoa.mattmakai.com;
  listen                443 ssl;
  ssl_certificate       /etc/nginx/cyoa/cyoa.crt;
  ssl_certificate_key   /etc/nginx/cyoa/cyoa.key;
  ssl_session_timeout   1d;
  ssl_session_cache     shared:SSL:50m;
  ssl_protocols         TLSv1.1 TLSv1.2;
  ssl_ciphers           'ECDHE-RSA-AES128-GCM-SHA256:ECDHE-ECDSA-AES128-GCM-SHA256:ECDHE-RSA-AES25
6-GCM-SHA384:ECDHE-ECDSA-AES256-GCM-SHA384:DHE-RSA-AES128-GCM-SHA256:DHE-DSS-AES128-GCM-SHA256:kED
H+AESGCM:ECDHE-RSA-AES128-SHA256:ECDHE-ECDSA-AES128-SHA256:ECDHE-RSA-AES128-SHA:ECDHE-ECDSA-AES12
8-SHA:ECDHE-RSA-AES256-SHA384:ECDHE-ECDSA-AES256-SHA384:ECDHE-RSA-AES256-SHA:ECDHE-ECDSA-AES256-SH
A:DHE-RSA-AES128-SHA256:DHE-RSA-AES128-SHA:DHE-DSS-AES128-SHA256:DHE-RSA-AES256-SHA256:DHE-DSS-AES2
56-SHA:DHE-RSA-AES256-SHA:AES128-GCM-SHA256:AES256-GCM-SHA384:AES128-SHA256:AES256-SHA256:AES128-SH
A:AES256-SHA:AES:CAMELLIA:DES-CBC3-SHA:!aNULL:!eNULL:!EXPORT:!DES:!RC4:!MD5:!PSK:!aECDH:!EDH-DSS-DE
S-CBC3-SHA:!EDH-RSA-DES-CBC3-SHA:!KRB5-DES-CBC3-SHA';
  ssl_prefer_server_ciphers   on;
```

```
  access_log   /var/log/nginx/cyoa.access.log;
  error_log   /var/log/nginx/cyoa.error.log info;
  keepalive_timeout  5;

  # nginx serve up static files and never send to the WSGI server
  location /static {
    autoindex on;
    alias /home/deployer/cyoa/static;
  }

  location / {
    proxy_set_header X-Forwarded-For $proxy_add_x_forwarded_for;
           proxy_set_header Host $http_host;
           proxy_redirect off;
           if (!-f $request_filename) {
             proxy_pass http://app_server_wsgiapp;
             break;
    }
  }

  # this section allows Nginx to reverse proxy for websockets
  location /socket.io {
    proxy_pass http://app_server_wsgiapp/socket.io;
    proxy_redirect off;
    proxy_buffering off;

    proxy_set_header Host $host;
    proxy_set_header X-Real-IP $remote_addr;
    proxy_set_header X-Forwarded-For $proxy_add_x_forwarded_for;

    proxy_http_version 1.1;
    proxy_set_header Upgrade $http_upgrade;
    proxy_set_header Connection "Upgrade";
  }
}
```

Now Nginx is configured with the SSL certificate we created in the earlier section and will only use secure methods to communicate with clients. Before the application works though, we have to restart with a new configuration. We handle the restarting of Nginx in the next section.

Restart Nginx with New Configuration

We need to restart the Nginx server to enable our new configuration. Perform these steps on your production server regardless of whether you set up HTTPS or just plain old HTTP in your configuration.

Delete the default website file if it exists.

```
sudo rm /etc/nginx/sites-enabled/default
```

Restart Nginx so the new configuration takes effect.

```
sudo service nginx restart
```

Our web server Nginx is now manually configured to serve up static files such as JavaScript, CSS and images. Nginx will also pass requests up to the WSGI server that it is running our Python application, including WebSocket connections. However, before we get the WSGI server running we need to clone our web application's source code onto the server. Cloning our source code is the subject of the next chapter.

If you are running through the manual steps first you can now flip to the next chapter on source control. To learn how to automate the Nginx configuration steps we just performed, keep reading below.

Automate Nginx Configuration

Our Ansible playbook needs new tasks to automate the Nginx configuration. Since this chapter had the option of using either plain old HTTP or HTTPS, we will create a flag in Ansible that can be flipped to set up the server with either HTTP or HTTPS, depending on a `deploy_ssl` variable.

Open `prod/group_vars/all` and append these new lines to the existing file.

```
# Chapter 4: Web Servers
## deploy_ssl true for HTTPS, false for only HTTP
deploy_ssl: true
wsgi_server_port: 8000
fqdn: cyoa.mattmakai.com
app_dir: /home/{{deploy_user}}/{{app_name}}
## local directory SSL certificates should be located here
ssl_certs_dir: ~/fsp-deployment-guide/ssl_cert/
```

Create a new file named `prod/roles/common/tasks/nginx_ssl.yml`. Ensure the file has the follow tasks, which install and configure Nginx for HTTPS connections.

```
##
# Configuration for Nginx web server
##
- name: ensure Nginx is installed via the system package
   apt: name=nginx state=present update_cache=yes
   sudo: yes

- name: create nginx ssl directory if it does not exist
  file: path=/etc/nginx/{{ app_name }} state=directory
  sudo: yes

- name: write SSL certificate file
  copy: src={{ ssl_certs_dir }}/{{ app_name }}.crt
        dest=/etc/nginx/{{app_name}}/{{app_name}}.crt
  sudo: yes
```

```
- name: write SSL key file
  copy: src={{ ssl_certs_dir }}/{{ app_name }}.key
        dest=/etc/nginx/{{ app_name }}/{{ app_name }}.key
  sudo: yes

- name: ensure default symbolic linked website is deleted
  file: path=/etc/nginx/sites-enabled/default state=absent
  sudo: yes

- name: write SSL nginx configuration
  template: src=nginx_ssl.conf.j2
            dest=/etc/nginx/conf.d/{{ app_name }}.conf
  sudo: yes
  notify:
    - restart nginx
```

Create another new file named `prod/roles/common/tasks/nginx_no_ssl.yml` with the following YAML. This file is used to install and configure Nginx when deploying only with HTTP based on the `deploy_ssl` variable.

```
###
# Configuration for Nginx web server without HTTPS
##
- name: ensure Nginx is installed via the system package
  apt: name=nginx state=present update_cache=yes
  sudo: yes

- name: ensure default symbolic linked website is deleted
  file: path=/etc/nginx/sites-enabled/default state=absent
  sudo: yes

- name: write non-SSL nginx configuration
  template: src=nginx_no_ssl.conf.j2
            dest=/etc/nginx/conf.d/{{ app_name }}.conf
  sudo: yes
  notify:
    - restart nginx
```

Create a file named `prod/roles/common/templates/nginx_ssl.conf.j2` that contains the following lines.

```
upstream app_server_wsgiapp {
     server localhost:{{ wsgi_server_port }} fail_timeout=0;
}

server {
 listen 80;
 server_name {{ fqdn }};
 rewrite ^(.*) https://$server_name$1 permanent;
}

server {
  server_name           {{ fqdn }};
  listen                443 ssl;
  ssl_certificate       /etc/nginx/{{ app_name }}/{{ app_name }}.crt;
  ssl_certificate_key   /etc/nginx/{{ app_name }}/{{ app_name }}.key;
  ssl_session_timeout   1d;
```

```
  ssl_session_cache     shared:SSL:50m;
  ssl_protocols         TLSv1.1 TLSv1.2;
  ssl_ciphers           'ECDHE-RSA-AES128-GCM-SHA256:ECDHE-ECDSA-AES128-GCM-SHA256:ECDHE-RSA-AES25
6-GCM-SHA384:ECDHE-ECDSA-AES256-GCM-SHA384:DHE-RSA-AES128-GCM-SHA256:DHE-DSS-AES128-GCM-SHA256:kED
H+AESGCM:ECDHE-RSA-AES128-SHA256:ECDHE-ECDSA-AES128-SHA256:ECDHE-RSA-AES128-SHA:ECDHE-ECDSA-AES12
8-SHA:ECDHE-RSA-AES256-SHA384:ECDHE-ECDSA-AES256-SHA384:ECDHE-RSA-AES256-SHA:ECDHE-ECDSA-AES256-SH
A:DHE-RSA-AES128-SHA256:DHE-RSA-AES128-SHA:DHE-DSS-AES128-SHA256:DHE-RSA-AES256-SHA256:DHE-DSS-AES2
56-SHA:DHE-RSA-AES256-SHA:AES128-GCM-SHA256:AES256-GCM-SHA384:AES128-SHA256:AES256-SHA256:AES128-SH
A:AES256-SHA:AES:CAMELLIA:DES-CBC3-SHA:!aNULL:!eNULL:!EXPORT:!DES:!RC4:!MD5:!PSK:!aECDH:!EDH-DSS-DE
S-CBC3-SHA:!EDH-RSA-DES-CBC3-SHA:!KRB5-DES-CBC3-SHA';
  ssl_prefer_server_ciphers   on;
  access_log            /var/log/nginx/{{ fqdn }}.access.log;
  error_log             /var/log/nginx/{{ fqdn }}.error.log info;
  keepalive_timeout     5;

  # nginx serve up static files and never send to the WSGI server
  location /static {
    autoindex on;
    alias {{ app_dir }}/{{ app_name }}/static;
  }

  location / {
    proxy_set_header X-Forwarded-For $proxy_add_x_forwarded_for;
           proxy_set_header Host $http_host;
           proxy_redirect off;
           if (!-f $request_filename) {
             proxy_pass http://app_server_wsgiapp;
             break;
    }
  }

  # this section allows Nginx to reverse proxy for websockets
  location /socket.io {
    proxy_pass http://app_server_wsgiapp/socket.io;
    proxy_redirect off;
    proxy_buffering off;

    proxy_set_header Host $host;
    proxy_set_header X-Real-IP $remote_addr;
    proxy_set_header X-Forwarded-For $proxy_add_x_forwarded_for;

    proxy_http_version 1.1;
    proxy_set_header Upgrade $http_upgrade;
    proxy_set_header Connection "Upgrade";
  }
}
```

Create another new file named `prod/roles/common/templates/nginx_no_ssl.conf.j2` that contains the following lines to configure the web server for just HTTP.

```
upstream app_server_wsgiapp {
  server localhost:{{ wsgi_server_port }} fail_timeout=0;
}

server {
 listen 80;
 server_name {{ fqdn }};
  access_log   /var/log/nginx/{{ fqdn }}.access.log;
  error_log   /var/log/nginx/{{ fqdn }}.error.log info;
  keepalive_timeout    5;
```

```
  # nginx serve up static files and never send to the WSGI server
  location /static {
    autoindex on;
    alias {{ app_dir }}/{{ app_name }}/static;
  }

  location / {
    proxy_set_header X-Forwarded-For $proxy_add_x_forwarded_for;
    proxy_set_header Host $http_host;
    proxy_redirect off;
    if (!-f $request_filename) {
      proxy_pass http://app_server_wsgiapp;
      break;
    }
  }

  # this section allows Nginx to reverse proxy for websockets
  location /socket.io {
    proxy_pass http://app_server_wsgiapp/socket.io;
    proxy_redirect off;
    proxy_buffering off;

    proxy_set_header Host $host;
    proxy_set_header X-Real-IP $remote_addr;
    proxy_set_header X-Forwarded-For $proxy_add_x_forwarded_for;

    proxy_http_version 1.1;
    proxy_set_header Upgrade $http_upgrade;
    proxy_set_header Connection "Upgrade";
  }
}
```

The above configuration is an Ansible template with tokens that will be replaced with values in variables from the `group_vars` directory when the playbook is executed. The result will be a file on our server that contains the same configuration file we otherwise would have to write manually.

Update `prod/roles/common/tasks/main.yml` by adding two new tasks to the end of the file to control whether to deploy with or without HTTPS depending on the `deploy_ssl` variable's value.

```
- include: nginx_ssl.yml
  when: deploy_ssl

- include: nginx_no_ssl.yml
  when: not deploy_ssl
```

There is one more file to create before Ansible will have what it needs to successfully automate the web server configuration. Create a file named `main.yml` within the `prod/roles/common/handlers` directory. Write the following lines into the file. This task restarts Nginx during the playbook execution when we use `notify` as part of a task, as we did in the `nginx_ssl.yml` and `nginx_no_ssl.yml` files.

```
- name: restart nginx
  service: name=nginx state=restarted
  sudo: yes
```

Run our Ansible playbook again with our shell script to install and configure Nginx on our server.

```
./deploy_prod.sh
```

Nginx is ready to serve HTTP requests but we need to run the WSGI server and our app to handle anything other than static files.

Next: Source Control

In the next chapter we will use Git to clone our source repository and ensure the appropriate code is on our server for the rest of the deployment.

More Web Server Resources

There are numerous guides that explain the underlying concepts web servers implement as well as how Nginx works. The links below are some of the best ones I have come across during my time learning how to perform deployments.

- The HTTP/1.1 and HTTP/2.0 specifications are the official sources for how these current HTTP versions work. Version 2.0 is gradually replacing 1.1 but for now you should read both specifications to understand the protocol from a primary source.
- Ars Technica has a detailed guide for how to set up a safe and secure Web server.
- Nginx for Developers: An Introduction provides exact steps for starting out with Nginx.
- A reference with the full list of HTTP status codes is provided by the W3C.
- A faster Web server: ripping out Apache for Nginx explains how Nginx has replaced Apache in some environments.

- Mozilla has a tool for creating SSL/TLS certificate configurations for web servers in case you want to check your settings against a recommended configuration.

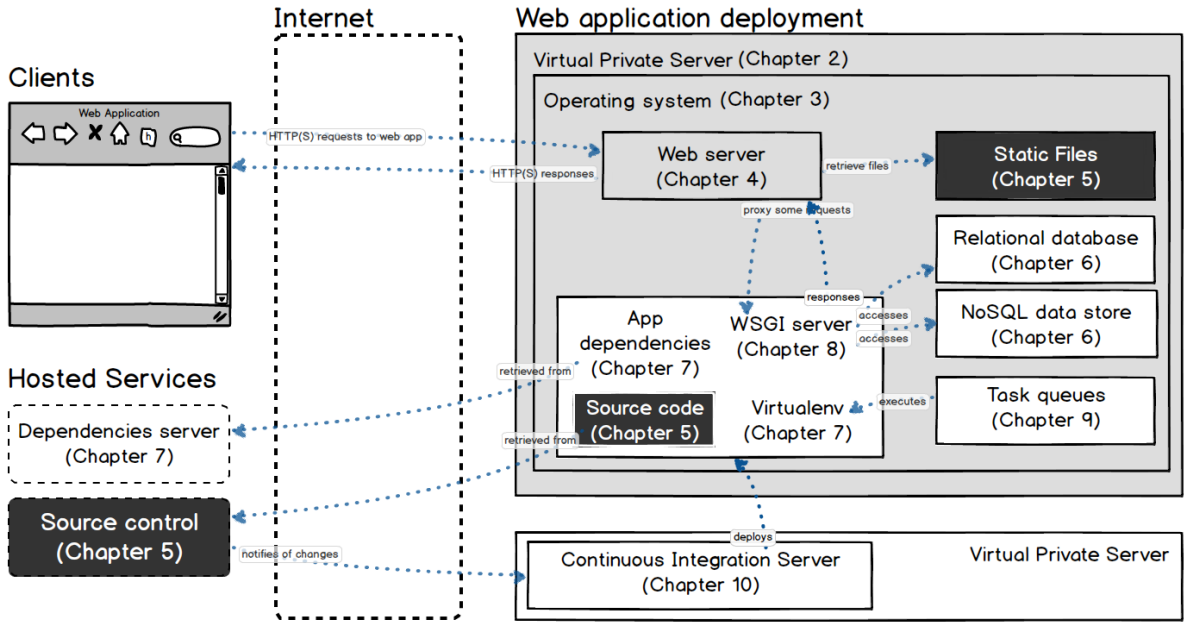
Chapter 5

Source Control

Source Control

Source control, also known as *version control*, stores source code files along with metadata on changes, such as character additions and deletions.

In an application deployment, source control can provide a bridge between the current production-ready version of the code stored on the server and the updates that need to be applied as the application continues to be worked on by developers.

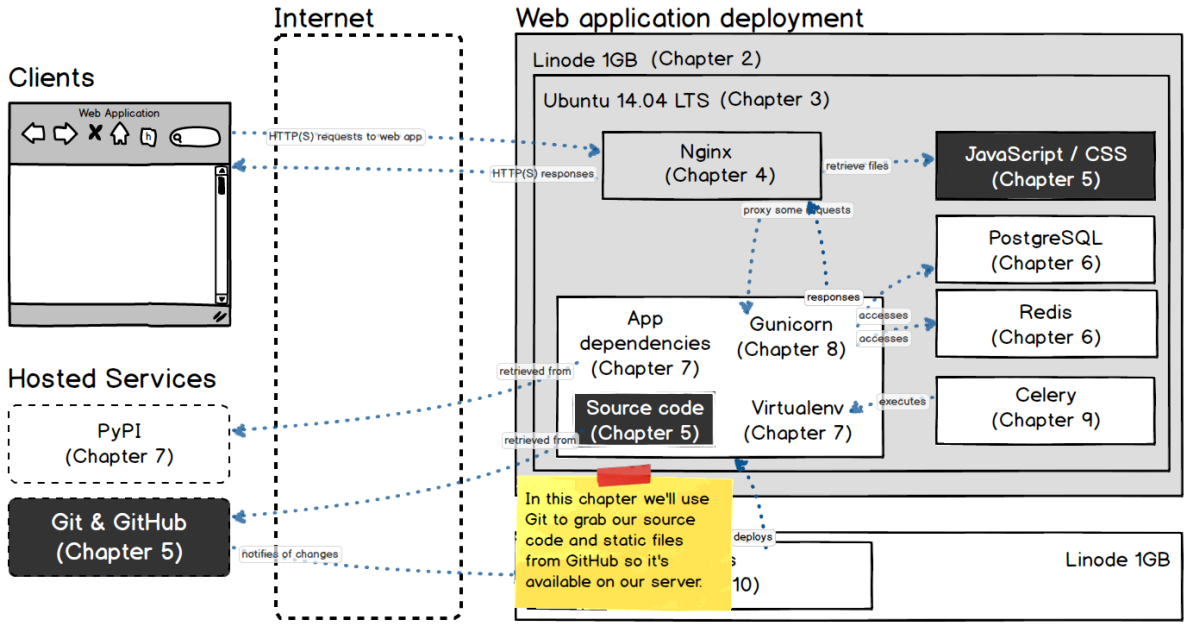


Version control systems allow developers to modify code without worrying about permanently screwing something up. Unwanted changes can be rolled back to a previous working code state.

Source control also eases developing software for teams. One developer can combine her code modifications with other developers' code by viewing differences in the code and merging in appropriate changes.

Note that some developers recommend deployment pipelines package the source code to deploy it and never have a production environment directly touch source control. However, for small scale deployments it is often easiest to directly pull updates from source code when you are getting started, instead of figuring out how to wrap the Python code in a system installation package.

Our deployment will use the source control deployment approach for getting our code onto the production server. This method for deploying code via the `git clone` and `git pull` commands will make our deployment process look like the following diagram.



Our deployment will use Git as our source control system and GitHub as a remote hosted source control service. In this chapter, we install Git, create a read-only deploy key and use Git to transfer our source code along with static files onto our server.

Hosted Source Control Services

We could install Git on a remote server and use that server to back up our source control, but it is easier to get started with a hosted version control service. You can transition away from the service at a later time by moving your repositories to your own server if your needs change. A few recommended hosted version control services are:

- GitHub is currently the most commonly used Git source control hosting platform.
- BitBucket provides free Git repositories for public projects and private repositories for up to five users.

- GitLab is newer than GitHub and BitBucket and is based on an open source project. GitLab as a company also hosts gitlab.com as an alternative to the closed source GitHub and BitBucket platforms.

As mentioned earlier, our deployment will use GitHub. Sign up for a free GitHub account now that we will use throughout this chapter.

Create Deploy Key

We need to create a deploy key separate from the key we use to log into the server. This deploy key will grant read-only access from our server to the single repository that we want to use the commands `git clone` and `git pull` to grab our code.

On the remote server create a new directory called `deploy_key`.

```
mkdir ~/deploy_key
cd ~/deploy_key
```

Execute the following command to create a new public-private key pair. **Perform these commands on your production server.**

```
# this is the same command we performed in the second
# chapter, but we're using it to create a deploy key now
# -t specifies the algorithm, -b argument specifies the
# number of bits to use
ssh-keygen -t rsa -b 2048
```

When prompted for a file in which to save the keys do not use the default. Instead, enter the following directory and file into the prompt.

```
# save the private key in our current directory
./deploy_key
```

Press enter twice when prompted for a passphrase. We will not use a passphrase on the deploy key.

Now you have two more new files: a private key named `deploy_key` and a public key named `deploy_key.pub`. Next we need to put the public key into GitHub so we can clone our code repository.

These new deploy keys are different than the `prod_key` and `prod_key.pub` that we created in the servers chapter. The deploy keys and prod keys cannot be used interchangeably. The `prod_key` is only used to log into our server,

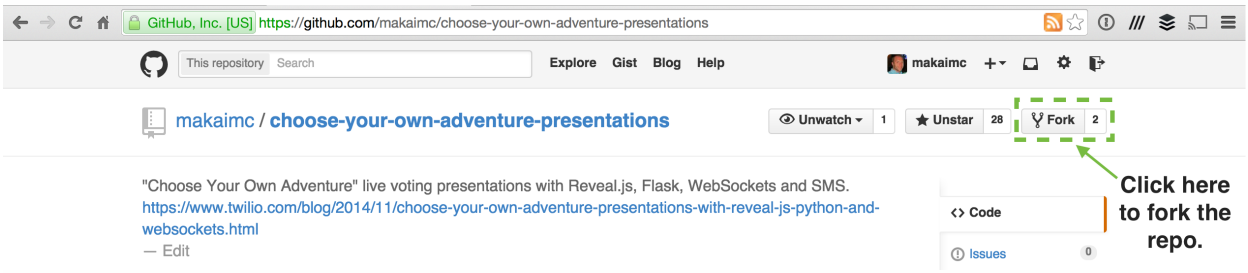
whereas the `deploy_key` can clone a Git repository from GitHub but cannot be used to log into our production server.

Authorize Git Clone Access

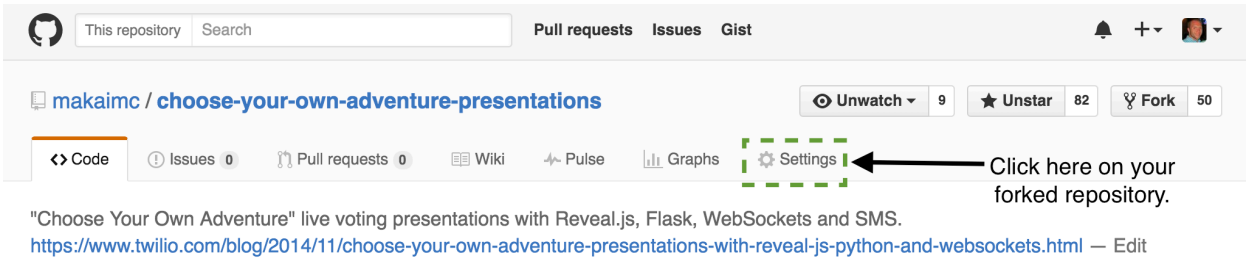
To execute the Git repository clone with our sample Flask app you need to fork the Choose Your Own Adventure Presentations project and add a deploy key. The following steps will walk through how to make that happen.

Go to the Choose Your Own Adventure Presentations repository page on GitHub.

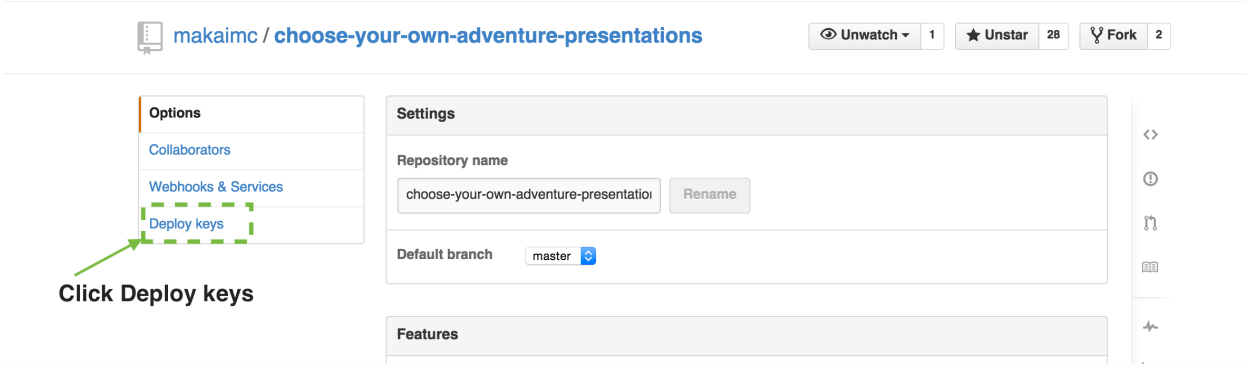
Press the fork button and select where to fork the repository.



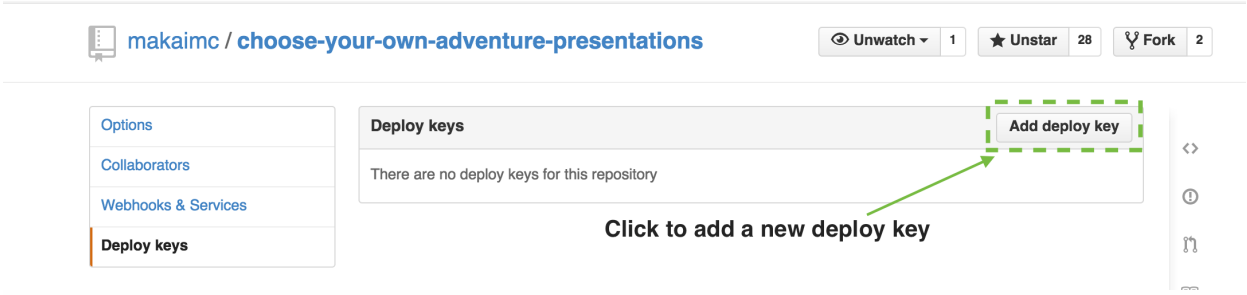
When the repository finishes forking the forked version's web page will appear. Add the deploy key we just created so that our new server can pull down the code. Click the settings link on the right navigation bar within the forked repository's page.



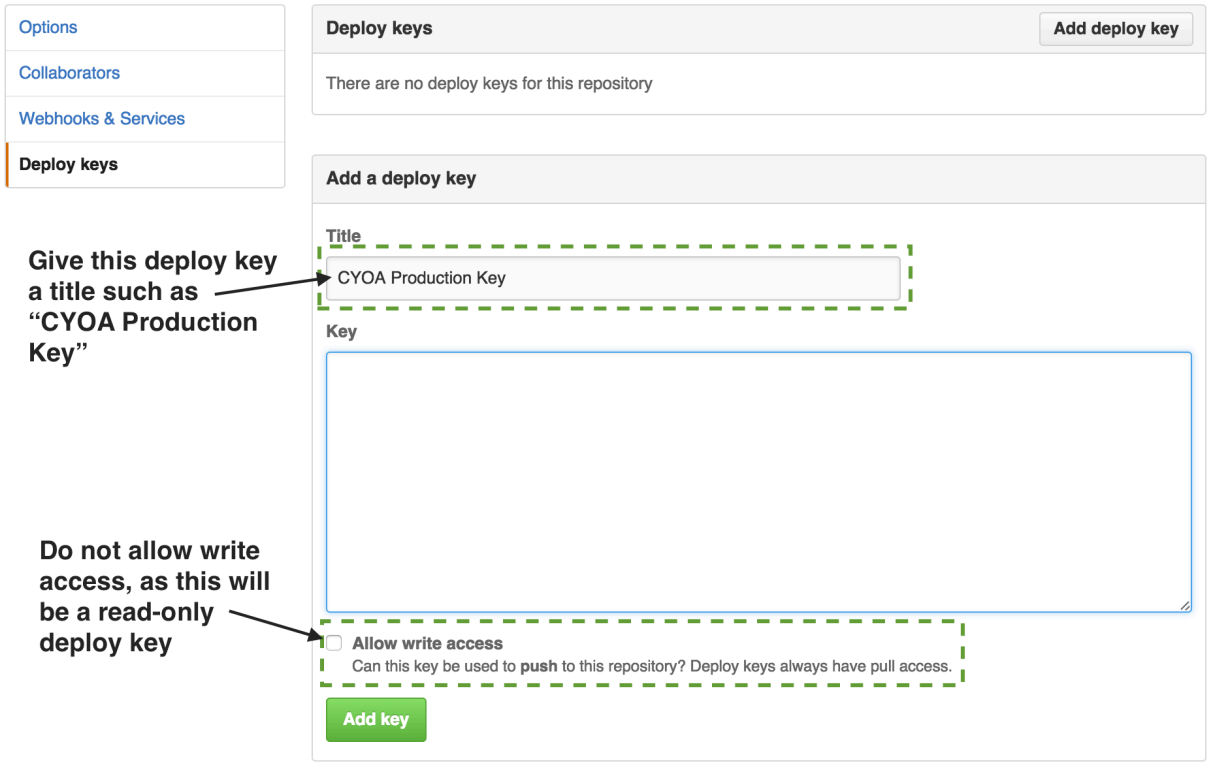
Click "Deploy Keys" on the left navigation bar.



Press the "Add deploy key" button.



Two text boxes will appear on the screen. Fill in a title and the contents of your `deploy_key.pub` key file. Make sure you use the `deploy_key.pub` file, not the private key stored in `deploy_key`. Do not allow write access.



Press the "Add Key" button. Now you're all set to clone this forked repository's code onto your production server.

Clone App Code

Git is not yet installed on the server so the first step will be to get the system package dependency. Once Git is installed we can pull down the application code from GitHub with our new deploy key.

Install the `git-core` package via apt on our remote machine.

```
sudo apt-get install git-core
```

Clone the remote Git repository so we have a copy of it on the server. If the repository is private the deploy key will grant you access. Be sure to use your username in the below command with the fork we created earlier.

```
ssh-agent bash -c 'ssh-add /home/deployer/deploy_key/deploy_key; \
git clone git@github.com:mattmakai/choose-your-own-adventures-presentations.git'
```

You will see a prompt asking if the authenticity of the host `github.com` is valid based on the key fingerprint. Enter 'yes' to continue.

If you run into the following error, you need to make sure your newly created public key is associated with your GitHub account.

```
Permission denied (publickey).
fatal: Could not read from remote repository.

Please make sure you have the correct access rights
and the repository exists.
```

If the clone works text similar to the following output will appear.

```
Cloning into 'cyoa'...
remote: Counting objects: 224, done.
remote: Total 224 (delta 0), reused 0 (delta 0), pack-reused 224
Receiving objects: 100% (224/224), 535.18 KiB | 0 bytes/s, done.
Resolving deltas: 100% (113/113), done.
Checking connectivity... done.
```

Now the repository is stored on the production server.

If we want to update the code by pulling the latest from the remote server we can run the following command.

```
ssh-agent bash -c 'ssh-add /home/deployer/deploy_key/deploy_key; git pull origin master'
```

That is all the manual work we need to do in this chapter. If you are ready to automate these steps within our Ansible playbook then continue reading below, otherwise we can begin setting up our PostgreSQL and Redis data stores in the next chapter.

Automate Source Control

We can automate almost all of the above steps in our deployment by building on our Ansible playbook. However, we will still have to manually create the deploy key and add it to GitHub just as we did in the above steps, even after the automation is done.

Update `prod/group_vars/all` to include the following new deployment variables at the end of the file.

```
# Chapter 5: Source Control
## this is the local directory with the deploy_key and deploy_key.pub
## files. do not include a trailing slash
local_deploy_key_dir: ~/fsp-deployment-guide/deploy_key
code_repository: ssh://git@github.com/mattmakai/choose-your-own-adventure-presentations.git
```

Create a new file `prod/roles/common/tasks/git.yml` with the following tasks to automate the source control installation on our server. The first task ensures Git is installed on the server via a system package. The second task copies the deploy key and the third task clones the latest web app code using the new deploy key.

```
###
# Clones or pulls the repo from a public or private Git repository
##
- name: ensure Git is installed via the system package
  apt: name=git-core state=present update_cache=yes
  sudo: yes

- name: create deploy key directory if it does not exist
  file: path=/home/{{ deploy_user }}/deploy_key state=directory

- name: ensure deploy key is on remote server
  copy: src={{ local_deploy_key_dir }}/deploy_key
        dest=/home/{{ deploy_user }}/deploy_key/deploy_key
        mode=0600 owner={{ deploy_user }} group={{ deploy_group }}

- name: clone or pull latest web app code
  git: repo={{ code_repository }} dest={{ app_dir }}
       key_file=/home/{{ deploy_user }}/deploy_key/deploy_key
       accept_hostkey=yes
```

Update `prod/roles/common/tasks/main.yml` with the following line at the end of the file.

```
- include: git.yml
```

Run our Ansible playbook again with our shell script. This time the playbook will also install Git, copy our deploy key from a local directory and clone the remote repository onto our server.

```
./deploy_prod.sh
```

Our Ansible playbook now allows the server to obtain our application code from source control. However, our application requires a backend database to store data.

Next: Databases

In the next chapter we'll install and configure a PostgreSQL relational database as well as an in-memory database called Redis.

More Source Control & Git Resources

Source control is a necessary tool for every software project. The following resources are fantastic for a better general understanding of how to properly use source control systems.

- Staging Servers, Source Control & Deploy Workflows, And Other Stuff Nobody Teaches You is a comprehensive overview by Patrick McKenzie of why you need source control.
- A visual guide to version control provides real-life examples for why version control is necessary in software development.
- An introduction to version control shows the basic concepts behind version control systems.
- About version control reviews the basics of distributed version control systems.

Git resources

Git is the source control system we use throughout this book. The following links are solid resources to learn more about Git.

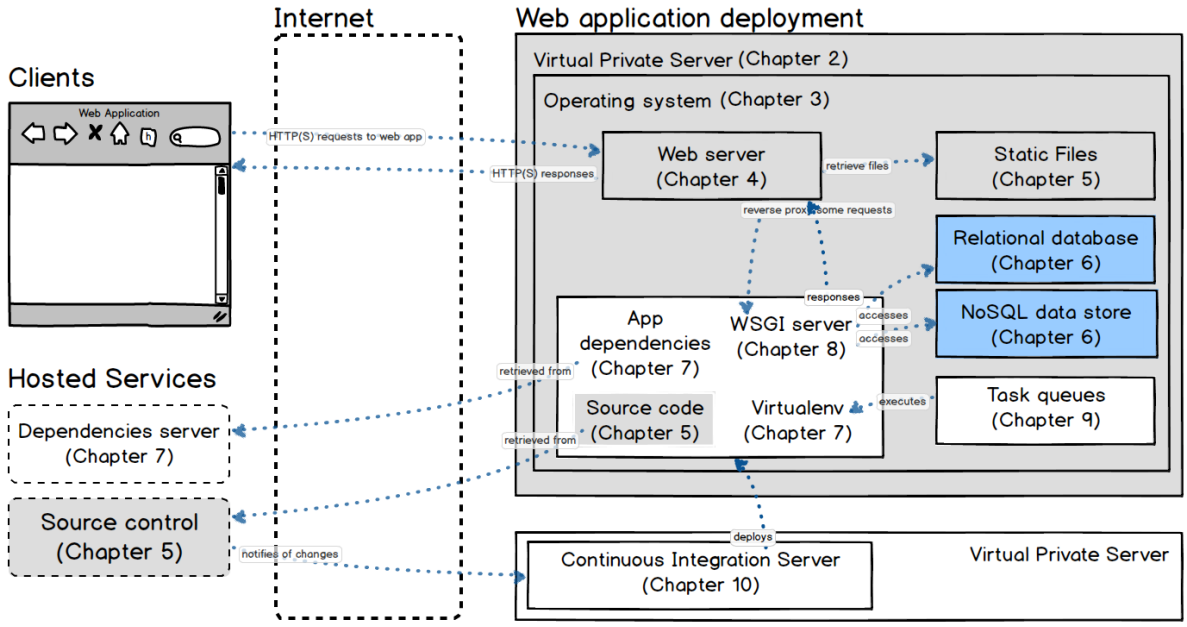
- Pro Git is a free open source book that walks through all aspects of using the version control system.
- A Hacker's Guide to Git covers the basics as well as more advanced Git commands while explaining each step along the way.
- Git Workflows That Work is a helpful post with diagrams to show how teams can create a Git workflow for their particular development process.

Chapter 6

Databases

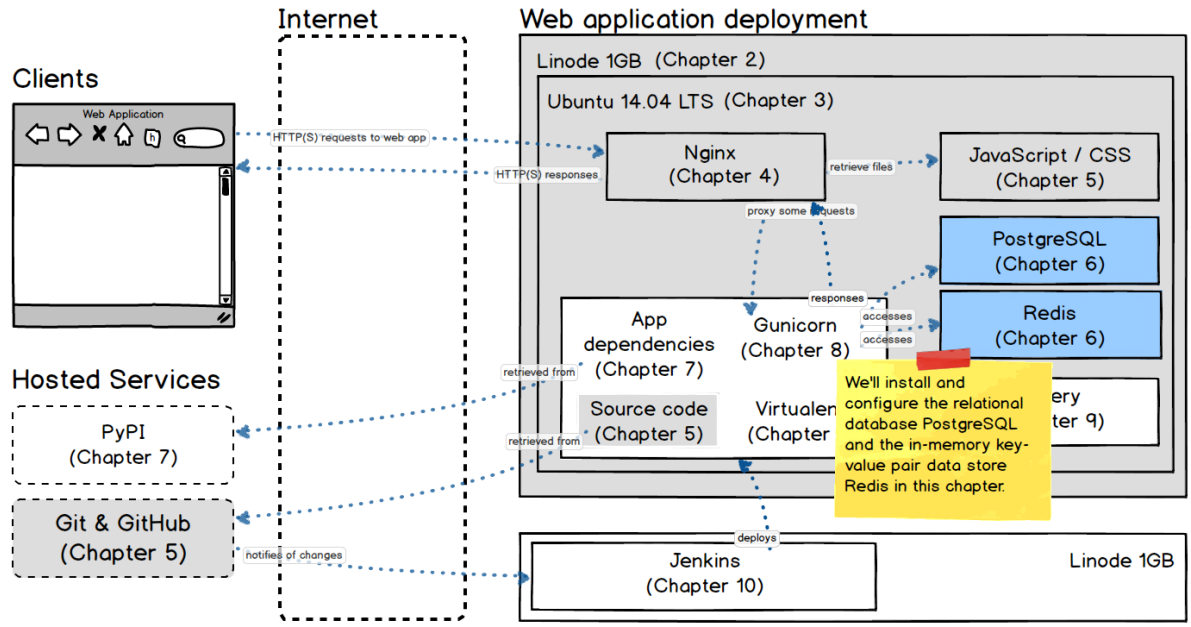
Databases

A persistent database is an abstraction on top of an operating system's file system that makes it easier for applications to create, read, update, and delete persistent data.



Relational databases store data in structured tables that are persisted to the file system. Databases provide a mental framework for how the data should be saved and retrieved instead of having to figure out what to do with the data every time you build a new application.

In this chapter, we will set up two types of databases. The first is a traditional relational database, PostgreSQL. The second database is generically called a "NoSQL data store". The one our application will use is an in-memory key-value pair store known as Redis.



As shown in the above diagram, PostgreSQL typically saves persistent data while Redis stores transient data in-memory that benefits from fast retrieval.

In the example Choose Your Own Adventure Presentations application, PostgreSQL handles persistent storage of users and presentations. Redis keeps transient data for the number of presentation votes that come in via text message voting.

Let's get to work on installing and configuring PostgreSQL.

PostgreSQL

PostgreSQL is the recommended relational database for working with Python web applications. PostgreSQL's feature set, active development and stability contribute to its wide usage as the backend for millions of production applications on the web today.

To work with a relational database using Python, you need to use a database driver. In our case we will use psycopg.

We need to install several new apt system packages to get PostgreSQL, along with the Python driver connection support, up and running.

- postgresql is the core database software

- libpq-dev provides development files so we can install the Python database connector, psycopg
- postgresql-client-common and postgresql-client are programs for connecting to the PostgreSQL database server

With explanations of the required packages out of the way, it's time to install and configure the database.

PostgreSQL can be installed via the system packages. Run the following command to kick off the installation.

```
sudo apt-get install postgresql libpq-dev \
postgresql-client-common postgresql-client
```

PostgreSQL is installed via the system package manager but we need create our database, set up a non-root user, set up our configuration and create our own tables.

Switch over to the `postgres` user using the following command.

```
sudo su - postgres
```

With the postgres user we can create the database that will hold our application's tables.

```
createdb cyoa
```

Next let's set up a non-root database user to handle the table creation and maintenance.

```
createuser --superuser deployer
```

We need to set a password for the deployer user. This password is separate from your superuser password so ensure you keep track of it so later we can configure the web application to connect to the database.

```
psql
ALTER USER deployer PASSWORD 'my new password';
```

Exit out of the psql prompt by pressing CTRL-d.

Log off the postgres user account by again pressing CTRL-d.

Now let's try out our PostgreSQL connection with the deployer user.

```
psql cyoa
```

You should see a prompt like `cyoa=#`.

Enter the following command at the PostgreSQL prompt and we'll see no tables have been created yet for the cyoa database.

```
\dt
No relations found.
```

Exit the PostgreSQL prompt by pressing CTRL-d or entering `\quit`.

You may have noticed the error that PostgreSQL could not save a history file. This history file needs to first be created for PostgreSQL to use it. There just needs to be a blank file in the deployer's home directory. Run the `touch` command to create the file.

```
touch ~/.psql_history
```

Our PostgreSQL database is installed and we can access it from the deployer account, but there is nothing in it yet. However, we will handle the initial data load in the next chapter after installing our application's dependencies.

NoSQL Data Stores

Relational databases store the vast majority of web application persistent data. However, there are several alternative database types that can also be used with web applications.

1. Key-value pair
2. Document-oriented
3. Column-family table
4. Graph

These persistent data storage representations are commonly used to augment, rather than completely replace, relational databases.

In this section of the chapter, we will install the Redis NoSQL data store to support our application.

Redis

Redis is an open source in-memory key-value pair data store. Redis is often called "the Swiss Army Knife of web application development." It can be used for caching, queuing, and storing session data for faster access than a traditional relational database, among many other use cases. Key-value pair data stores are based on hash map data structures and when they're stored in memory they are much faster than accessing data from persistent storage.

It is possible to install Redis by compiling its source code but in this case the easiest route for us is to install the Ubuntu 14.04 LTS package.

Install Redis from the apt repository.

```
sudo apt-get install redis-server
```

Testing the Redis Installation

Both `redis-server` and the `redis-cli` command line interface are now installed.

If you already know how to use Redis you can skip this section because we are just going to run through a few basic Redis client commands.

We can test the installation using the following command.

```
redis-cli
```

The following command-line interface should appear.

```
127.0.0.1:6379>
```

Values can be retrieved from Redis via the `get` command followed by the key name. For example:

```
127.0.0.1:6379> get cyoa
(nil)
```

A value for the key 'cyoa' has not been set so the value returned is specified as `nil`. Let's set it now and get the new set value.

```
127.0.0.1:6379> set cyoa 1
OK
```

```
127.0.0.1:6379> get cyoa
"1"d
```

Strings are the basic data type in Redis so we receive back our 1 as a String. However we can perform operations on the value that are more integer-like such as increment and decrement. We'll try that real quick before moving on with our deployment.

```
127.0.0.1:6379> incr cyoa
(integer) 2
127.0.0.1:6379> get cyoa
"2"
```

Redis understands the increment operation and increases the value to 2. When we retrieve the value through a get though Redis still returns the value back as the basic String data type.

Redis is operating with default settings which will suffice for our web application deployment. We can now continue our manual set up in the next chapter on application dependencies or automate this part of the deployment in the remainder of this chapter.

Automate PostgreSQL & Redis Installations

We can augment our existing Ansible playbook to install and configure the PostgreSQL and Redis databases.

Append the following new database-related variables to the existing `prod/group_vars/all` file.

```
# Chapter 6: Databases
db_url: postgresql://{{deploy_user}}:{{db_password}}@localhost/{{app_name}}
## make sure to change this password to what you want your
## database password to be!
db_password: fortheloveofgodpleaseuseagoodpassword
db_name: "{{ app_name }}"
db_user: "{{ deploy_user }}"
```

Add a new file `prod/roles/common/tasks/postgresql.yml` with the following Ansible YAML.

```
###
# Installs and configures the PostgreSQL database
#
- name: ensure postgresql database packages are installed
  apt: name={{item}}
  sudo: yes
```

```
  with_items:
    - postgresql
    - libpq-dev
    - python-psycopg2
    - postgresql-client
    - postgresql-client-common

- name: ensure database is created
  postgresql_db: name={{ app_name }}
  sudo: yes
  sudo_user: postgres

- name: configure separate PostgreSQL user
  postgresql_user: db={{ app_name }} name={{ db_user }}
                   password={{ db_password }} priv=ALL
                   role_attr_flags=NOSUPERUSER
  sudo: yes
  sudo_user: postgres
```

Add one more new file called `prod/roles/common/tasks/redis.yml` with this YAML to install the `redis-server` package.

```
###
# Installs and configures Redis
##
- name: ensure redis package is installed
  apt: name=redis-server state=present update_cache=yes
  sudo: yes
```

Update `prod/roles/common/tasks/main.yml` to include the following new highlighted lines.

```
##
# configures the server and installs the web application
##
- include: ubuntu.yml

- include: nginx_ssl.yml
  when: deploy_ssl

- include: nginx_no_ssl.yml
  when: not deploy_ssl

- include: git.yml

- include: postgresql.yml
- include: redis.yml
```

Make sure to again run our Ansible playbook again with our shell script to install and configure the databases on our server.

```
./deploy_prod.sh
```

Next: Application Dependencies

In the next chapter we will handle the application dependencies with a virtualenv, `requirements.txt` file and PyPI.

More Database Resources

Numerous resources for relational databases and NoSQL data stores are available to continue learning about the best ways to use these technologies. Here is a list of useful ones I have come across in the past couple of years.

- DB-Engines ranks the most popular database management systems.
- DB Weekly is a weekly roundup of general database articles and resources.
- The object-relational mappers (ORMs) page on Full Stack Python provides a detailed comparison of Python ORMs often used with relational databases in Python web applications.
- Databases integration testing strategies covers a difficult topic that comes up in just about every real world software project.

PostgreSQL resources

PostgreSQL is commonly used as a relational open source database with Python web applications. Here are several resources that helped me better understand how to use the tool.

- This post on using PostgreSQL with Django or Flask is a great quickstart guide for either framework.
- PostgreSQL Weekly is a weekly newsletter of PostgreSQL content from around the web.
- Braintree wrote about their experiences scaling PostgreSQL. The post is an inside look at the evolution of Braintree's usage of the database.
- There is no such thing as total security but this IBM article covers hardening a PostgreSQL database.

NoSQL Resources

The NoSQL ecosystem can be a tricky beast to figure out. In most application deployments, a relational database does the heavy lifting for persistent storage and NoSQL data stores are used for special cases, such as caching, indexing and search term retrieval.

- CAP Theorem overview is a ground up explanation of the principles behind data persistence mechanisms.
- NoSQL Weekly is a free curated email newsletter that aggregates articles, tutorials, and videos about non-relational data stores.
- NoSQL comparison is a large list of popular, BigTable-based, special purpose, and other data stores with attributes and the best use cases for each one.
- What is a key/value store database? is a straightforward Stack Overflow answer to this question.

Redis Resources

Here are some additional handy tutorials for installing and using Redis.

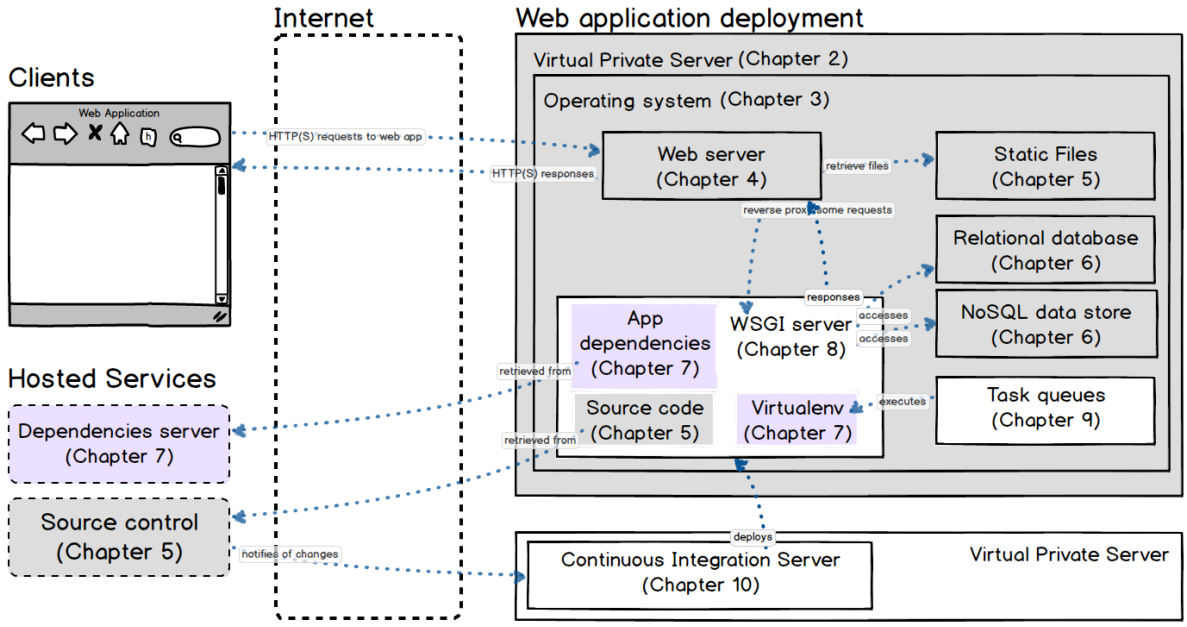
- How To Install and Use Redis provides a guide for getting up and running with the extremely useful in-memory data store.
- Getting started with Redis and Python is a walkthrough for installing and playing around with the basics of Redis.
- Scaling Redis at Twitter is a story from using Redis in the development trenches at the social media company.

Chapter 7

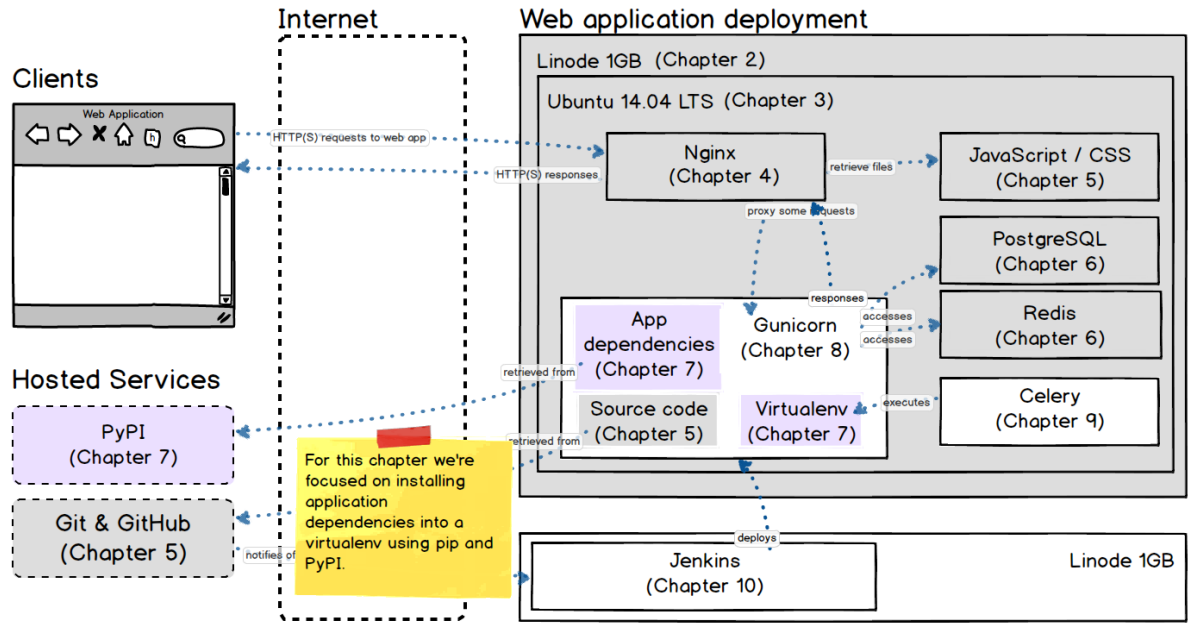
Application Dependencies

Application Dependencies

Application dependencies are the external libraries your project requires to execute your application code. For example, our Choose Your Own Adventure Presentations sample web application relies on the Flask microframework, so a reference to that library is stored in the project's `requirements.txt` file and will be installed as an application dependency.



In this chapter we will install our application dependencies via the pip command, which downloads the libraries from PyPI and installs them into a virtualenv.



In this chapter we will take a further look at how application dependencies work then dive into getting the necessary dependencies installed for our deployment to the production environment.

Our Deployment Dependencies

Python web applications are built upon the work done by thousands of open source programmers. Application dependencies include not only web frameworks but also libraries for scraping, parsing, processing, analyzing, visualizing and many other tasks. Python's ecosystem facilitates discovery, retrieval and installation so it is easier for developers to code their applications.

Our deployment will continue in this chapter by performing the following configuration:

1. Create a virtualenv for a fresh Python installation environment
2. Install the necessary application dependencies listed in the `requirements.txt` file by using the `pip` command to retrieve the libraries from PyPI
3. Populate environment variables so that our program can access them

Before we jump into our manual steps let's take a quick look at why we need to isolate dependencies, how a `requirements.txt` file is used and explain dependency pegging.

Virtualenv & requirements.txt

Dependencies are installed separately from system-level packages to prevent library version conflicts. The most common isolation method for Python application is using a virtualenv. Each virtualenv is its own copy of the Python interpreter and dependencies in the `site-packages` directory. To use a virtualenv it must first be created with the `virtualenv` command and then activated.

The virtualenv stores dependencies in an isolated environment. The web application then relies only on that virtualenv instance to run.

The Python convention for specifying application dependencies is a `requirements.txt` file. When you build a Python web application you should always include a `requirements.txt` file with your project's pegged dependencies. "Pegging" dependencies means attaching a specific version number after the name of the dependency.

For example, in our Choose Your Own Adventure Presentations application the `requirements.txt` file with pegged dependencies looks like this:

```
Flask==0.10.1
Flask-Script==2.0.5
Flask-SocketIO==0.4.1
Flask-Login==0.2.11
Flask-SQLAlchemy==2.0
Flask-WTF==0.10.3

gunicorn==19.3.0
redis==2.10.3
twilio==3.7.2
psycopg2==2.5.4
celery==3.1.18
```

Pegged dependencies with precise version numbers or Git tags are important because otherwise the latest version of a dependency will be used. While it may sound good to always stay up to date, there's no telling if your application actually works with the latest versions of all dependencies. Developers should deliberately upgrade and test to make sure there were no backwards-incompatible modifications in newer dependency library versions.

Create the Virtualenv

It is time to create our virtualenv for this project so we can run our Python code. Make sure you are logged into the remote production server with the deployer user to execute the following commands.

Create a directory to store virtualenvs.

```
mkdir /home/deployer/envs/
```

Name the new virtualenv `cyoa`, an acronym for "Choose Your Own Adventure".

```
virtualenv /home/deployer/envs/cyoa
```

Activate the virtualenv.

```
source /home/deployer/envs/cyoa/bin/activate
```

We should see a prefix to the shell like the following. That prefix helps us remember which virtualenv is currently active.

```
(cyoa)$
```

Now the virtualenv is activated for our shell. However, this activation is not automatic for every shell that is opened. Our virtualenv is only activated for the shell we explicitly activate it for.

We can also use other commands in the `bin` directory without activating the virtualenv first though. For example, we could run the Python interpreter within that virtualenv by running the following command.

```
/home/deployer/envs/cyoa/bin/python
```

Install App Dependencies

With our virtualenv activated we can install the web application's dependencies.

Install the necessary Choose Your Own Adventure Presentations project dependencies with `pip` into the `cyoa` virtualenv.

```
pip install -r /home/deployer/cyoa/requirements.txt
```

Copy the `template.env` file to a new file named `.env`.

```
cp template.env .env
```

Fill in the following necessary environment variables in the new `.env` file.

```
 #!/bin/bash
 export DEBUG=False
 export SECRET_KEY='supersecretproductionkeyforapp'
 export DATABASE_URL='postgres://username:password@localhost/cyoa'

 # Redis settings
 export REDIS_SERVER='localhost'
 export REDIS_PORT='6379'
 export REDIS_DB='1'

 # Twilio settings
 export TWILIO_ACCOUNT_SID=''
 export TWILIO_AUTH_TOKEN=''
 export TWILIO_NUMBER=''

 # Celery
 export CELERY_BROKER_URL='redis://localhost:6379/0'
 export CELERY_RESULT_BACKEND='redis://localhost:6379/0'
 ```

Invoke the environment variables by running the shell script on the
command line from the `cyoa` base directory.
```

(cyoa)$ . .env ```

We can test that the dependencies are properly installed and that the environment variables were invoked by syncing the web application with the database.

## Sync Database

Our database is ready for table creation, so let's run a command from the `manage.py` file.

```
(cyoa)$ python manage.py syncdb
```

No output is likely a good sign that the tables created without a problem, but we can check PostgreSQL to be certain.

Connect to PostgreSQL with the deployer user.

```
psql cyoa
```
```

You will see a new prompt like `cyoa=#` that tells us we are in the PostgreSQL client.

Enter the following command at the PostgreSQL prompt and we'll now see that tables have been created in the database for our application.

```
cyoa=# \dt
             List of relations
 Schema |     Name      | Type  |  Owner
--------+---------------+-------+----------
 public | choices       | table | deployer
 public | presentations | table | deployer
 public | wizards       | table | deployer
(3 rows)
```

Populate Initial Data

Most applications that are deployed need some initial data populated to run properly. In our Choose Your Own Adventure Presentations application we only need a Wizard user so we can log into the Wizard admin panel.

We synced our database tables, but we need the user for our application. Run the following command to create a user with a username and password of your choice.

```
(cyoa)$ python manage.py create_wizard username password
```

Our database tables and new user are ready to go. If you want to finish off the manual application deployment and populate some of the initial database data, move on to the next chapter on WSGI server. For the remainder of this chapter we will automate the above steps.

Automate Dependency Installation

Time to make further changes to our Ansible deployment playbook so we can automate our application dependencies installation.

Update `prod/group_vars/all` with the following new highlighted lines at the end of the file.

```
# Chapter 3: Operating System (Ubuntu)
app_name: cyoa
deploy_user: deployer
deploy_group: deployers
## this is the local directory with the SSH keys and known_hosts
```

```
## file do not include a trailing slash
ssh_dir: ~/devel/py/fsp-deployment-guide/ssh_keys


# Chapter 4: Web Servers
## deploy_ssl true for HTTPS, false for only HTTP
deploy_ssl: false
wsgi_server_port: 8000
fqdn: cyoa.mattmakai.com
app_dir: /home/{{deploy_user}}/{{app_name}}
## local directory SSL certificates should be located here
ssl_certs_dir: ~/devel/py/fsp-deployment-guide/ssl_cert/


# Chapter 5: Source Control
local_deploy_key_dir: ~/fsp-deployment-guide/deploy_key
code_repository: ssh://git@github.com/mattmakai/choose-your-own-adventure-presentations.git


# Chapter 6: Databases
db_url: postgresql://{{deploy_user}}:{{db_password}}@localhost/{{app_name}}
db_password: fortheloveofgodpleaseuseagoodpassword
db_name: "{{ app_name }}"
db_user: "{{ deploy_user }}"


# Chapter 7: Application Dependencies
venv_dir: "/home/{{ deploy_user }}/envs/{{ app_name }}"
venv_python: "{{venv_dir}}/bin/python"
wsgi_env_vars: {
  DEBUG: True,
  SECRET_KEY: 'jqwpifojqwoifjioqwjfoiqwj',
  DATABASE_URL: '{{ db_url }}',
  REDIS_SERVER: 'localhost',
  REDIS_PORT: 6379,
  REDIS_DB: 1,
  TWILIO_ACCOUNT_SID: 'ACxxxxxxxxxxxxxxxxxxxxxx',
  TWILIO_AUTH_TOKEN: 'yyyyyyyyyyyyyyyyyyyyyy',
  TWILIO_NUMBER: '+12027598445',
  CELERY_BROKER_URL: 'redis://localhost:6379/0',
  CELERY_RESULT_BACKEND: 'redis://localhost:6379/0',
}
## username you want to use to log into app's admin screen
app_admin_user: ''
## password you want to use to log into app's admin screen
app_admin_password: ''
```

Create a new file named `dependencies.yml` under `prod/roles/common/tasks/`. Fill in the following lines in the new file.

```
# Handles application dependencies and environment variables
Also syncs the application with the database schema

- name: create virtualenv directory if it does not already exist
  file: path={{ venv_dir }} state=directory

- name: install dependencies into a new virtualenv
  pip: requirements={{ app_dir }}/requirements.txt
       virtualenv={{ venv_dir }}

- name: create .env file in base directory of the app from template
  template: src=env.j2
```

```
            dest={{ app_dir }}/.env

- name: sync the database tables between Flask and PostgreSQL
  shell: ". {{ app_dir }}/.env; {{ venv_python }} {{ app_dir }}/manage.py syncdb"

- name: create the initial admin user in the database
  shell: ". {{ app_dir }}/.env; {{ venv_python }} {{ app_dir}}/manage.py create_wizard {{ app_admi
n_user }} {{ app_admin_password }}"
```

Create a new file named `prod/roles/common/templates/env.j2`. Ensure you created the file in the templates directory and not under tasks like the file we just created in the previous step. Fill in the following lines.

```
{% raw %}
#!/bin/bash
{% for k, v in wsgi_env_vars.iteritems() %}
export {{ k }}="{{ v }}"
{% endfor %}
{% endraw %}
```

The above template loops through the WSGI environment variables set for `wsgi_env_vars` in the `group_vars/all` file and fills them into the `.env` file.

The `.env` file won't actually be used for running the application except if we need to SSH in manually and test the installation. Environment variables for our deployment are set in the Supervisor configuration file instead.

Update `prod/roles/common/tasks/main.yml` to include the following new highlighted lines.

```
###
# configures the server and installs the web application
##
- include: ubuntu.yml

- include: nginx_ssl.yml
  when: deploy_ssl

- include: nginx_no_ssl.yml
  when: not deploy_ssl

- include: git.yml
- include: postgresql.yml
- include: redis.yml
- include: dependencies.yml
```

Run our Ansible playbook again with our shell script to install the application dependencies, set the environment variables and sync the database schema with the application's models.

```
./deploy_prod.sh
```

Next: WSGI Server

In the next chapter we will run the WSGI server, Gunicorn, which will execute our Python code and bring up our web application.

More Application Dependency Resources

Application dependencies can be annoying to install on your production server when you just want to get your app up and running. This chapter walked you through the basic steps for making that happen and automating it in future deployments. Check out the following resources if you want more information to better understand what is happening under the covers and what further steps to take next.

- Jon Chu wrote a great introduction on virtualenv and pip basics.
- A non-magical introduction to virtualenv and pip breaks down what problems these tools solve and how to use them.
- Tools of the modern Python hacker contains detailed explanations of virtualenv, Fabric, and pip.
- Occasionally arguments about using Python's dependency manager versus one of Linux's dependency managers comes up. This post provides one perspective on that debate.
- This Stack Overflow question details how to set up a virtual environment for Python development.

Python Package Resources

It can be useful to browse through these lists in case you come across a library to solve a problem by reusing the code instead of writing it all yourself. A few of the best collections of Python libraries are:

- Python.org's useful modules groups modules into categories.
- GitHub Explore Trending Python repositories shows the open source Python projects that have recently gained stars and forks.

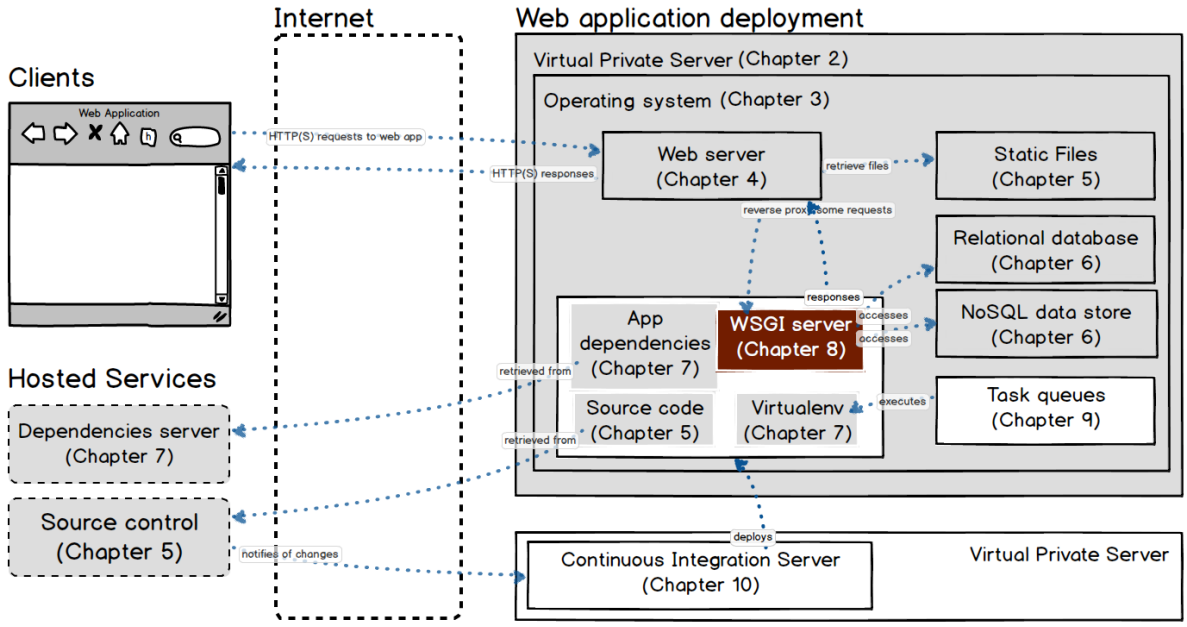
- This list of 20 Python libraries you can't live without is a wide-ranging collection from data analysis to testing tools.
- awesome-python is a huge list of Python frameworks, libraries and software.
- easy-python is like awesome-python although instead of just a Git repository this site is in the Read the Docs format.
- awesome-django provides Python libraries related to the Django web application framework.

Chapter 8

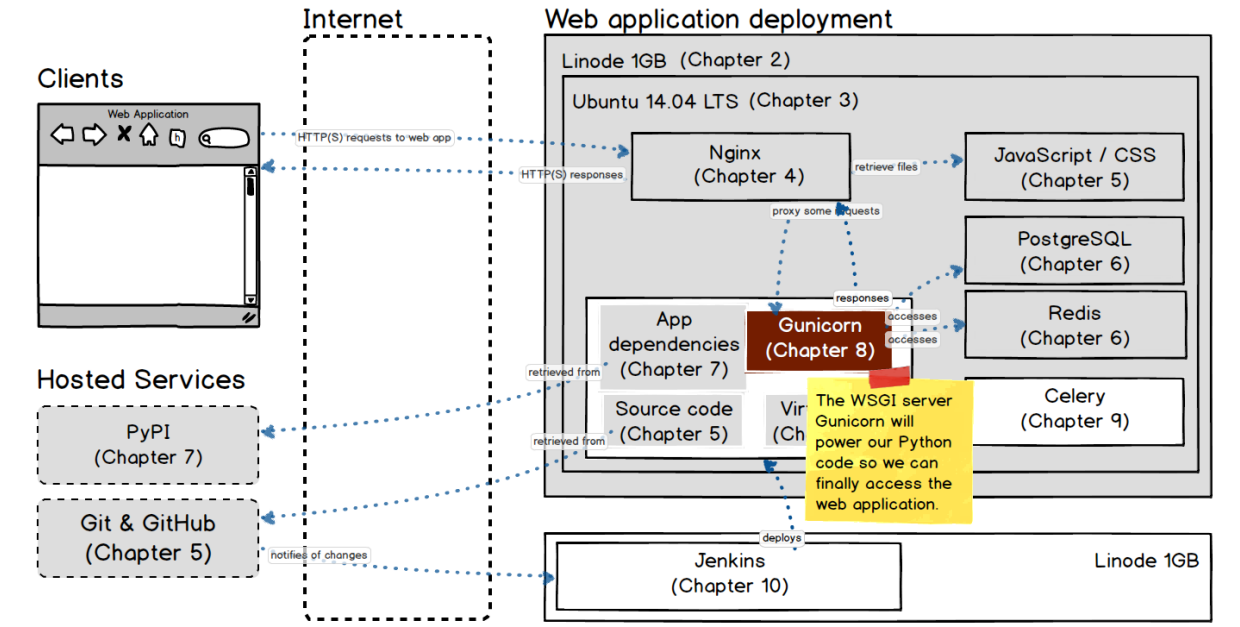
WSGI Servers

WSGI Servers

A Web Server Gateway Interface (WSGI) server runs Python web applications that implement the WSGI Application interface defined in the PEP3333 standard.



Our WSGI server implementation for this chapter is Gunicorn, which is short for "Green Unicorn".



We'll start out with an explanation of the WSGI specification, take a look at a few options for our implementation, configure the server manually and then augment our existing Ansible playbook to automate our Green Unicorn configuration.

What is WSGI?

Traditional web servers such as Apache and Nginx do not understand or have any way to run Python. In the late 1990s, a developer named Grisha Trubetskoy came up with an Apache module called mod_python to execute arbitrary Python code. For several years in the late 1990s and early 2000s, Apache configured with mod_python ran most Python web applications.

However, mod_python wasn't a standard specification. It was just an implementation that allowed Python code to run on a server. As mod_python's development stalled and security vulnerabilities were discovered there was recognition by the community that a consistent way to execute Python code for web applications was needed.

Therefore the Python community came up with WSGI as a standard interface that modules and containers could implement. WSGI is now the accepted approach for running Python web applications.

If you're using a standard web framework that implements the WSGI application side such as Django, Flask or Bottle then your application can be deployed in the same way as the Choose Your Own Adventure Presentations application. Likewise, if you're using a standard WSGI container such as Green Unicorn, uWSGI, mod_wsgi or gevent, you can get them running without worrying about how they implement the WSGI standard.

There is a comprehensive list of WSGI servers on the WSGI Read the Docs page. The following are WSGI servers based on community recommendations.

- uWSGI is gaining steam as a highly-performant WSGI server implementation.
- mod_wsgi is an Apache module implementing the WSGI specification.
- CherryPy is a pure Python web server that also functions as a WSGI server.
- Green Unicorn (Gunicorn) is a pre-fork worker model based server ported from the Ruby Unicorn project.

In this chapter, we're going to use the Green Unicorn WSGI server implementation to run our application.

Configure Gunicorn

Our deployment will use Green Unicorn (gunicorn) as our WSGI server. Fortunately `gunicorn` is specified as a dependency in our `requirements.txt` file so it is already installed in our virtualenv.

Activate the virtualenv if it is not already enabled.

```
source /home/deployer/envs/cyoa/bin/activate
```

Our virtualenv active prompt should show up on the command line.

```
(cyoa)$
```

Change into the `cyoa` project directory.

```
cd ~/cyoa
```

Activate our environment variables for the application.

```
. .env
```

Start up gunicorn manually to ensure the web application is working.

```
(cyoa)$ gunicorn cyoa:app
```

Our application should be up and running now, so let's test it out. Go to the URL you set up as your hostname. In my case, the URL to visit is `http://cyoa.mattmakai.com/`. If we see the following screen, our application is running properly.

No presentations are found since we have not yet loaded any data into the application.

Start Gunicorn with Supervisor

We typically do not want to run the Gunicorn server by manually logging into the server. Instead, we can use the Supervisor tool to start (and stop or restart) the WSGI server for us.

Supervisor is not yet installed on the system so we need to obtain it via a system package. Then we just need to create a configuration file and start the `supervisor` process once to get it running.

Install the `supervisor` package via `apt` on our remote machine.

```
sudo apt-get install supervisor
```

Create a new file within the `/etc/supervisor/conf.d/` directory named `cyoa.conf` with the following contents. Remember that you will need to replace the environment values with your own application's values, including the `TWILIO_NUMBER`.

```
[program:cyoa]
environment=DEBUG=False,SECRET_KEY=mysupersecretkeyhere,REDIS_SERVER="localhost",REDIS_PORT=6379,RE
DIS_DB=0,TWILIO_ACCOUNT_SID="ACxxxxxx",TWILIO_AUTH_TOKEN="authtokenvalue",TWILIO_NUMBER="+120255512
34",DATABASE_URL="postgresql://deployer:databasepw@localhost/cyoa"
command=/home/deployer/envs/cyoa/bin/gunicorn cyoa:app
directory=/home/deployer/cyoa
user=deployer
autostart=true
autorestart=true
redirect_stderr=True
```

Save the file then start Supervisor with the following command.

```
sudo service supervisor start
```

That will do it for Supervisor, so let's test out our application.

Our App is Live!

Our app should be up and running at the URL we specified now. Let's give it a test with the "Wizards Only" sign in page. Go to http://cyoa.mattmakai.com/wizard/ and you should see the following screen (replace the root URL with the server you set up to test your own application):

If that screen shows up, we are looking good! There are no users in the application yet though so we cannot log in. We will fix the no users issue when we load the initial database data.

Automate Gunicorn Configuration

Create a new file `prod/roles/common/tasks/wsgi.yml` that will have new YAML instructions for Ansible to execute.

```
###
# Sets up and configures Supervisor which runs Green Unicorn
##
- name: ensure Supervisor is installed via the system package
  apt: name=supervisor state=present update_cache=yes
  sudo: yes

- name: create Supervisor template for the WSGI app to run
  template: src=supervisor_app.conf.j2
            dest=/etc/supervisor/conf.d/{{ app_name }}.conf
  sudo: yes

- name: stop supervisor for app
  command: service supervisor stop
  sudo: yes

- name: pause for restart to take effect
  pause: seconds=2

- name: start supervisor for app
  command: service supervisor start
  sudo: yes
  notify:
    - restart nginx
```

Add a new file `prod/roles/common/templates/supervisor_app.conf.j2` with the following content. **Important note**: there *must* be a blank line between the `environment=...` and `command=` lines or the output from Ansible will merge onto one line. PDFs and EPUB formats often do not preserve the blank line in output so be sure to check the tagged file on GitHub if you want to be certain your template file is correct.

```
{% raw %}
[program:{{ app_name }}]
environment={% for k, v in wsgi_env_vars.iteritems() %}{% if not loop.first %},{% endif %}{{ k
}}="{{ v }}"{% endfor %}

command={{ venv_dir }}/bin/gunicorn {{ app_name }}:app
directory={{ app_dir }}
user={{ deploy_user }}
autostart=true
autorestart=true
redirect_stderr=True
{% endraw %}
```

Update the existing `prod/roles/common/tasks/main.yml` file by appending the following highlighted line.

```
###
# configures the server and installs the web application
##
- include: ubuntu.yml

- include: nginx_ssl.yml
  when: deploy_ssl

- include: nginx_no_ssl.yml
  when: not deploy_ssl

- include: git.yml
- include: postgresql.yml
- include: redis.yml
- include: dependencies.yml
- include: wsgi.yml
```

As we did in prior chapters, re-run the Ansible playbook with our shell script.

```
./deploy_prod.sh
```

Next: Task Queue

Our application is up and running, but there is more configuration left work to do. In order to handle asynchronous background tasks, we need to set up a task queue on our server. We'll learn more about task queues and the Celery task queue implementation in the next chapter.

More WSGI Resources

There are many resources available for both specifications and implementations of WSGI applications and servers. I recommend starting with the PEP 3333 standard as it's an accessible read and gives a good foundation for other materials you read about WSGI.

- The WSGI standard v1.0 is specified in PEP 0333. As of September 2010, WSGI v1.0 is superseded by PEP 3333, which defines the v1.0.1 WSGI standard.
- This basics of WSGI post contains a simple example of how a WSGI-compatible application works.
- The Python community made a long effort to transition from mod_python to the WSGI standard. That transition period is now complete and an implementation of WSGI should always be used instead mod_python.

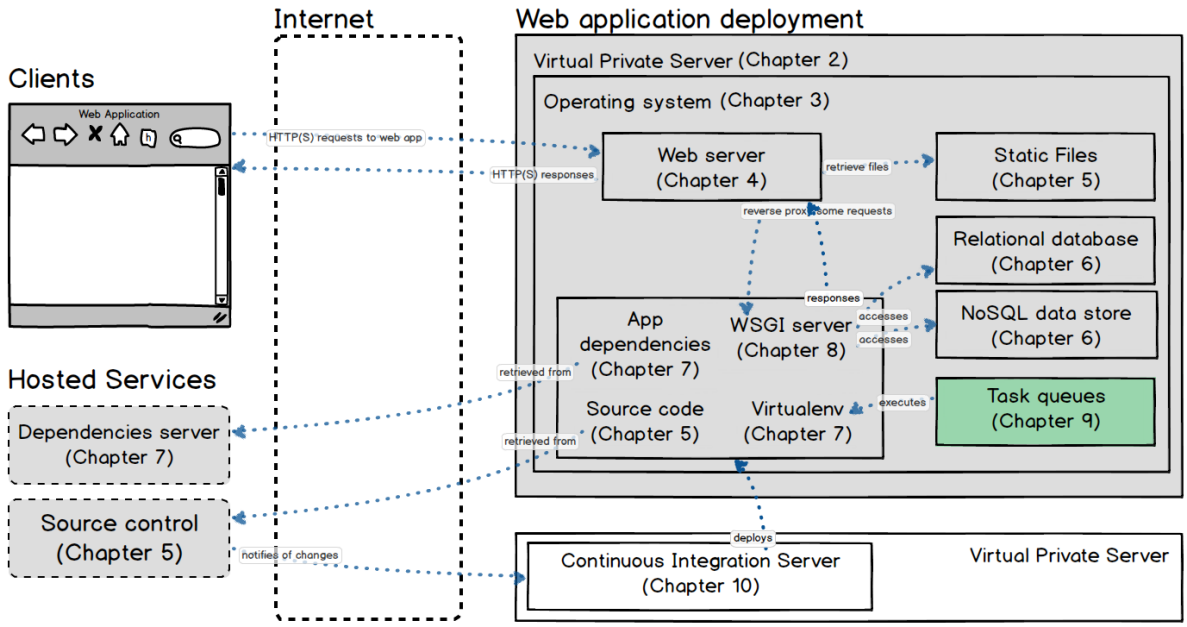
- A thorough and informative post for LAMP-stack hosting choices is presented in the complete single server Django stack tutorial.
- Nicholas Piël wrote an interesting benchmark blog post of Python WSGI servers. Note that the post is a few years old. Benchmarks should be considered for their specific tested scenarios and not quickly extrapolated as general "this server is definitely faster than this other server" results.

Chapter 9

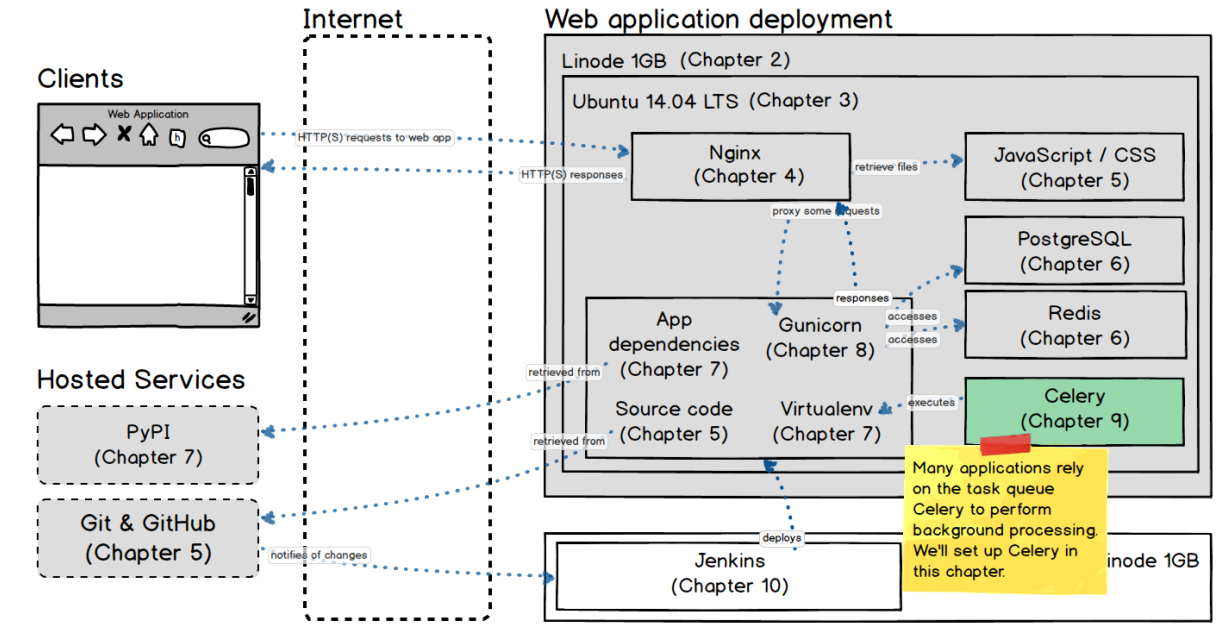
Task Queues

Task Queues

Task queues manage background work that must be executed outside the usual HTTP request-response cycle.



In this chapter our deployment continues by setting up a particular task queue implementation, Celery, that is commonly used with Python web applications.



Celery will connect to Redis, which we previously set up in the databases chapter, to use as a message queue broker.

What Are Task Queues For?

Tasks are handled asynchronously either because they are not initiated by an HTTP request or because they are long-running jobs that would dramatically reduce the performance of an HTTP response.

For example, a web application could poll the GitHub API every 10 minutes to collect the names of the top 100 starred repositories. A task queue would handle invoking code to call the GitHub API, process the results and store them in a persistent database for later use.

Another example is when a database query would take too long during the HTTP request-response cycle. The query could be performed in the background on a fixed interval with the results stored in the database. When an HTTP request comes in that needs those results a query would simply fetch the pre-calculated result instead of re-executing the longer query.

Other types of jobs for task queues include

- spreading out large numbers of independent database inserts over time instead of inserting everything at once

- aggregating collected data values on a fixed interval, such as every 15 minutes
- scheduling periodic jobs such as batch processes

Task Queue Implementations

The defacto standard Python task queue is Celery. The other task queue projects that arise tend to come from the perspective that Celery is overly complicated for simple use cases. My recommendation is to put the effort into Celery's reasonable learning curve as it is worth the time it takes to understand how to use the project.

- The Celery distributed task queue is the most commonly used Python library for handling asynchronous tasks and scheduling.
- The RQ (Redis Queue) is a simple Python library for queueing jobs and processing them in the background with workers. RQ is backed by Redis and is designed to have a low barrier to entry. The intro post contains information on design decisions and how to use RQ.
- Taskmaster is a lightweight simple distributed queue for handling large volumes of one-off tasks.

We'll set up Celery manually now. As with previous chapters, later we will automate the installation with additions to our Ansible playbook.

Celery

To set up our task queue Celery, we need to create two new Supervisor configuration files. Supervisor will run both the `celery` command, which handles the queue, and `celerybeat`, which runs periodic tasks.

Log into your production server. We are going to create two new templates that will configure Supervisor processes: `celery` to process tasks and `celerybeat` to run periodic tasks.

Write a new file `/etc/supervisor/conf.d/supervisor_celery.conf` for Celery. You'll need to use the `sudo` command to write in that directory. For alpha values such as "localhost", you will need to use double quotes around

the value. For numeric values, quotes are not necessary but you can include them anyway.

```
[program:celery]
environment=environment=DEBUG=False,SECRET_KEY=mysupersecretkeyhere,REDIS_SERVER="localhost",REDI
S_PORT=6379,REDIS_DB=0,TWILIO_ACCOUNT_SID="ACxxxxxx",TWILIO_AUTH_TOKEN="authtokenvalue",TWILIO_NUMB
ER="+12025551234",DATABASE_URL="postgresql://deployer:databasepw@localhost/cyoa",CELERY_RESULT_BACK
END="redis://localhost:6379/0",CELERY_BROKER_URL="redis://localhost:6379/0"

command=/home/deployer/envs/cyoa/bin/celery worker -l info -P gevent -A cyoa.celery
directory=/home/deployer/cyoa
user=deployer
autostart=true
autorestart=true
redirect_stderr=True
```

Create another new file `/etc/supervisor/conf.d/supervisor_celerybeat.conf` for Celerybeat. You'll need to use the `sudo` command to write in that directory. Again, make sure to replace the values in the "environment" line with your own values.

```
[program:celerybeat]
environment=environment=DEBUG=False,SECRET_KEY=mysupersecretkeyhere,REDIS_SERVER="localhost",REDI
S_PORT=6379,REDIS_DB=0,TWILIO_ACCOUNT_SID="ACxxxxxx",TWILIO_AUTH_TOKEN="authtokenvalue",TWILIO_NUMB
ER="+12025551234",DATABASE_URL="postgresql://deployer:databasepw@localhost/cyoa",CELERY_RESULT_BACK
END="redis://localhost:6379/0",CELERY_BROKER_URL="redis://localhost:6379/0"

command=/home/deployer/envs/cyoa/bin/celery beat -A cyoa.celery
directory=/home/deployer/cyoa
user=deployer
autostart=true
autorestart=true
redirect_stderr=True
```

Stop Supervisor.

```
sudo service supervisor stop
```

Pause just a moment to make sure Supervisor is completely stopped. Start Supervisor so the new configuration files take effect.

```
sudo service supervisor start
```

Supervisor is now up and running again with both the `celery` and `celerybeat` programs running.

Automate Celery Install

We can add a few files to our Ansible playbook to automate the task queue configuration.

Append the following new highlighted variables so that your `prod/group_vars/all` file looks similar to the following, but with your specific values instead of the defaults.

```
# Chapter 3: Operating System (Ubuntu)
app_name: cyoa
deploy_user: deployer
deploy_group: deployers
## this is the local directory with the SSH keys and known_hosts
## file do not include a trailing slash
ssh_dir: ~/fsp-deployment-guide/ssh_keys


# Chapter 4: Web Servers
## deploy_ssl true for HTTPS, false for only HTTP
deploy_ssl: false
wsgi_server_port: 8000
fqdn: cyoa.mattmakai.com
app_dir: /home/{{deploy_user}}/{{app_name}}
## local directory SSL certificates should be located here
ssl_certs_dir: /~/fsp-deployment-guide/ssl_cert/


# Chapter 5: Source Control
local_deploy_key_dir: ~/fsp-deployment-guide/deploy_key
code_repository: ssh://git@github.com/mattmakai/choose-your-own-adventure-presentations.git


# Chapter 6: Databases
db_url: postgresql://{{deploy_user}}:{{db_password}}@localhost/{{app_name}}
## make sure to change this password to what you want your
## database password to be!
db_password: fortheloveofgodpleaseuseagoodpassword
db_name: "{{ app_name }}"
db_user: "{{ deploy_user }}"


# Chapter 7: Application Dependencies
venv_dir: "/home/{{ deploy_user }}/envs/{{ app_name }}"
venv_python: "{{venv_dir}}/bin/python"
flask_env_vars: {
    ## in production you'll likely want to set this to False
    DEBUG: True,
    ## make sure to set your own unique long secret key for your app
    SECRET_KEY: 'super secret key make sure to change this',
    DATABASE_URL: '{{ db_url }}',
    REDIS_SERVER: 'localhost',
    REDIS_PORT: 6379,
    REDIS_DB: 1,
    ## these next two environment variables are found in the
    ## Twilio account dashboard on twilio.com
    TWILIO_ACCOUNT_SID: 'found on the twilio dashboard',
    TWILIO_AUTH_TOKEN: 'also found on the twilio dashboard',
    ## grab a number on Twilio for the application and Ansible
    TWILIO_NUMBER: '+15551234567',
    CELERY_BROKER_URL: 'redis://localhost:6379/0',
    CELERY_RESULT_BACKEND: 'redis://localhost:6379/0',
}
## username you want to use to log into app's admin screen
app_admin_user: ''
## password you want to use to log into app's admin screen
app_admin_password: ''
```

```
# Chapter 8: WSGI Servers
## no new variables necessary for this chapter

# Chapter 9: Task queues
deployment_alert: true
## your phone number that should receive a deployment complete
## text message. example format: "+19735551234"
alert_number: ""
```

Create a new file `prod/roles/common/tasks/celery.yml` that will configure both the `celery` and `celerybeat` programs that are necessary for asynchronous and periodic tasks in our application.

```
###
# Sets up and configures Supervisor for Celery and Celerybeat
##
- name: create Supervisor template for Celery to run
  template: src=supervisor_celery.conf.j2
            dest=/etc/supervisor/conf.d/{{ app_name }}_celery.conf
  sudo: yes

- name: create Supervisor template for Celerybeat to run
  template: src=supervisor_celerybeat.conf.j2
            dest=/etc/supervisor/conf.d/{{ app_name }}_celerybeat.conf
  sudo: yes

- name: stop supervisor for celery
  command: service supervisor stop
  sudo: yes

- name: pause for restart to take effect
  pause: seconds=2

- name: start supervisor for celery
  command: service supervisor start
  sudo: yes
```

Create two new templates for Supervisor, one each for `celery` and `celerybeat`.

Create a new file named `prod/roles/common/templates/supervisor_celery.conf.j2`, which will be a template for Supervisor to run Celery. **Important note**: there *must* be a blank line between the `environment=...` and `command=` lines or the output from Ansible will merge onto one line. PDFs and EPUB formats often do not preserve the blank line in output so be sure to check the tagged file on GitHub if you are uncertain about the correct formatting.

```
{% raw %}
[program:celery]
environment={% for k, v in wsgi_env_vars.iteritems() %}{% if not loop.first %},{% endif %}{{ k
}}="{{ v }}"{% endfor %}
```

```
command={{ venv_dir }}/bin/celery worker -l info -P gevent -A {{ app_name }}.celery
directory={{ app_dir }}
user={{ deploy_user }}
autostart=true
autorestart=true
redirect_stderr=True
{% endraw %}
```

Write another new file `prod/roles/common/templates/supervisor_celerybeat.conf.j2` that Supervisor will use to start Celerybeat. Again, one more **important note**: there *must* be a blank line between the `environment=...` and `command=` lines or the output from Ansible will merge onto one line. PDFs and EPUB formats often do not preserve the blank line in output so be sure to check the tagged file on GitHub for the correct formatting.

```
{% raw %}
[program:celerybeat]
environment={% for k, v in wsgi_env_vars.iteritems() %}{% if not loop.first %},{% endif %}{{ k
}}="{{ v }}"{% endfor %}

command={{ venv_dir }}/bin/celery beat -A {{ app_name }}.celery
directory={{ app_dir }}
user={{ deploy_user }}
autostart=true
autorestart=true
redirect_stderr=True
{% endraw %}
```

Update `prod/roles/common/tasks/main.yml` to include the new `celery.yml` file at the end and send a text message alert once the deployment is completed.

```
- include: celery.yml

- name: alert that deployment is complete
  twilio:
    msg: "Deployment complete!"
    account_sid: "{{ wsgi_env_vars.TWILIO_ACCOUNT_SID }}"
    auth_token: "{{ wsgi_env_vars.TWILIO_AUTH_TOKEN }}"
    from_number: "{{ wsgi_env_vars.TWILIO_NUMBER }}"
    to_number: "{{ alert_number }}"
  delegate_to: localhost
  when: deployment_alert
```

Re-run the Ansible playbook with our shell script from the base directory of our deployment project. This time we won't have to wait in front of the computer screen for the deployment to finish. If you have set up the `alert_number` variable to text your cell phone, you will receive a text message when the deployment completes.

```
./deploy_prod.sh
```

Next: Continuous Integration

We have our Celery task queue running with background jobs. Next up we will use the Ansible playbook to automate the entire deployment to production whenever code is committed and pushed to the master branch of our repository on GitHub.

More Task Queue Resources

Task queues are critical for creating performant web applications by shifting workloads into the background instead of trying to handle all work during the HTTP request-response cycle. Here are more resources for learning about task queue concepts and implementations.

- Queues.io contains a collection of task queue implementations with short summaries for each one. The task queues are not built in Python but ones that work with Python applications are tagged with the "Python" keyword.
- Why Task Queues is a presentation for what task queues are and why they are needed.
- Asynchronous Processing in Web Applications: Part One and Part Two are great reads for understanding the difference between a task queue and a message queue broker, as well as why you shouldn't use your database as a message queue.

Celery Resources

Celery is a fantastic open source implementation of task queues. Here are few further resources on when and when not to use Celery in your projects.

- Getting Started Scheduling Tasks with Celery is a detailed walkthrough for setting up Celery with the Django web framework.
- Introducing Celery for Python+Django provides an introduction to the Celery task queue.

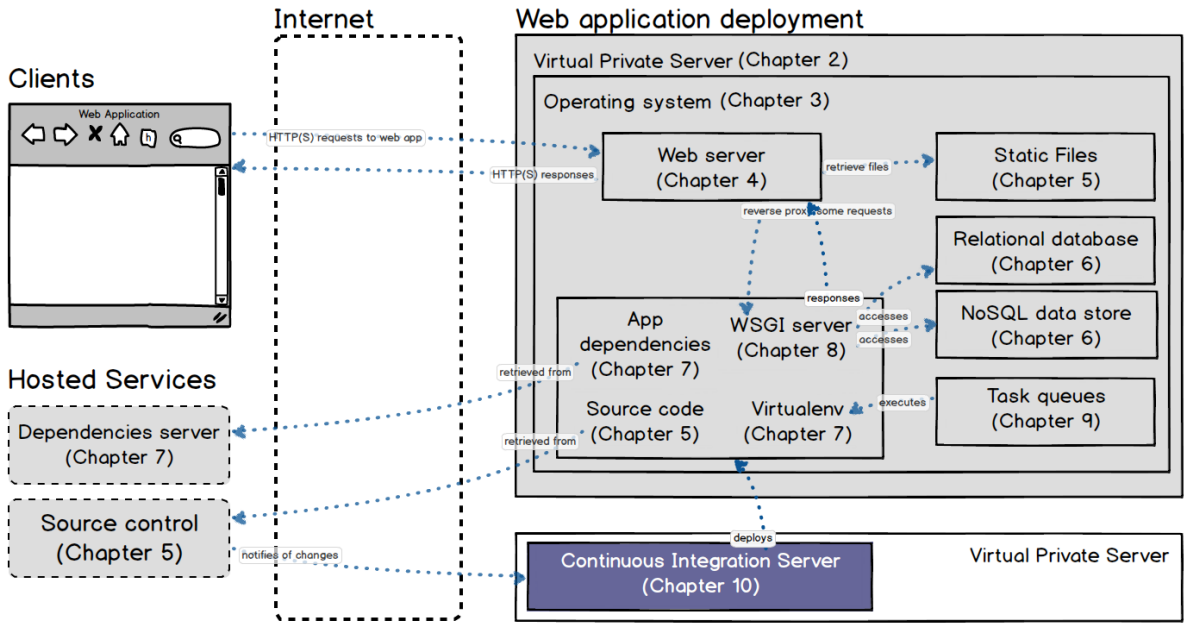
- Celery - Best Practices explains ways you should not use Celery. The post also shows some underused features for making task queues easier to work with.

Chapter 10

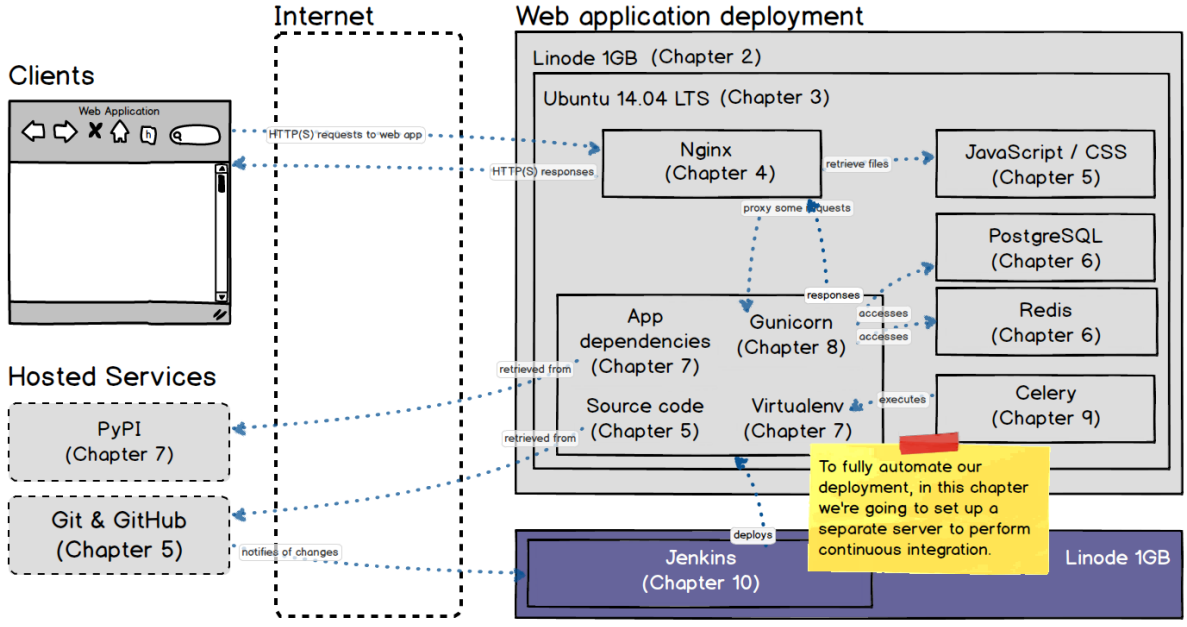
Continuous Integration

Continuous Integration

Continuous integration (CI) automates building, testing and deploying applications.



In this chapter, we will set up Jenkins as our continuous integration server.



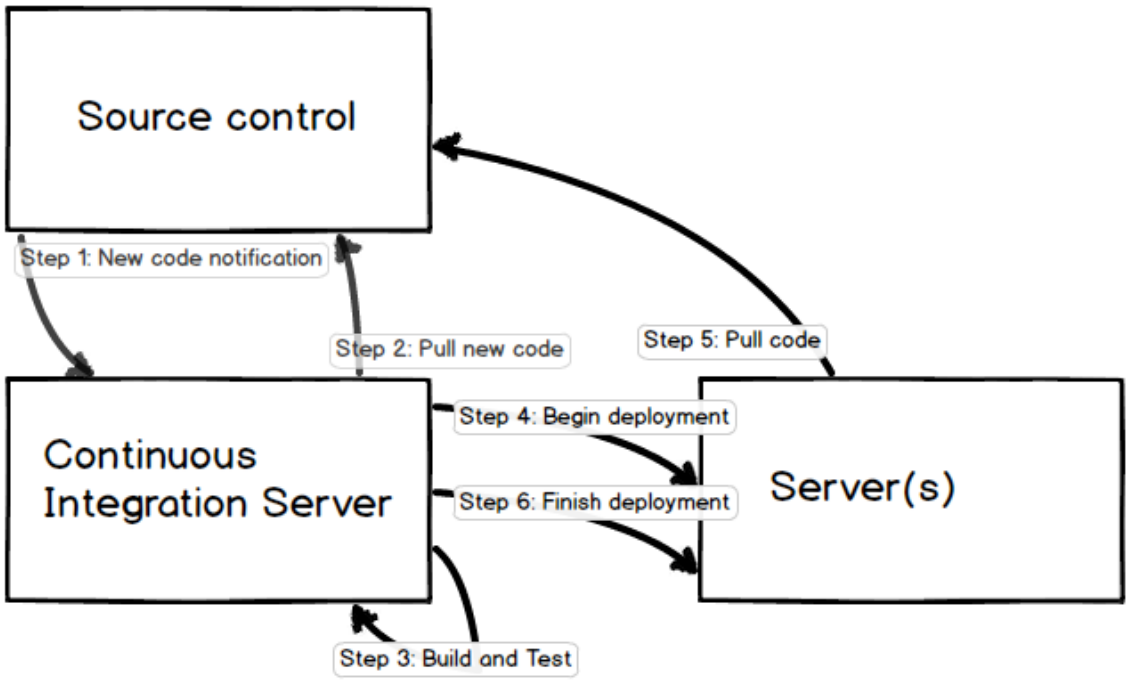
Jenkins will listen for HTTP POST requests from GitHub alerting it to when new code is pushed to our Git repository.

When CI is set up well it can greatly reduce deployment times by eliminating manual steps. Continuous integration also can ensure code does not have bugs by checking for them with automated unit and integration tests. Source code constantly changes as a project evolves. CI combined with testing makes it less likely that modifications to existing code do not break functionality and that software works as intended.

Jenkins

For our project we will set up Jenkins to pull source code from GitHub, build and test it then deploy it to our server. Jenkins is widely used and open source. However, there is a list of other open source and hosted continuous integration servers listed at the end of the chapter in case you want to try a different CI server out.

The continuous integration and deployment environment we set up will look like the following diagram.



When we push changes to our remote source control repository on GitHub, an HTTP POST request will be sent to our Jenkins server. That POST request

informs Jenkins that a new build is required. Jenkins will pull the latest code from GitHub, make sure it's ready then deploy it to our production server using the Ansible playbook we've written throughout the book.

In a larger environment continuous integration would typically deploy the newest code to a test server for some manual checks before going to production. However, with this application we are keeping our set up as simple as possible and just deploying it straight into production.

Let's get moving to set up our continuous integration environment!

Provision A New Server for CI

We need another virtual private server to host our continuous integration environment so we are going to create a new public-private key pair and lock down the server using our Fabric script from chapter 2.

On your local machine, create a new directory at the base directory of our deployment project named `jenkins_ci`.

```
mkdir jenkins_ci
cd jenkins_ci
```

Execute the following command on your local machine to create a new public-private key pair just for the continuous integration server.

```
# we're running ssh-keygen command to generate the key pair
# -b argument specifies the number of bits, 2048 in our case
# along with -t argument to specify the RSA algorithm
ssh-keygen -t rsa -b 2048
```

When prompted for a file in which to save the keys do not use the default. Instead, enter the following directory and file into the prompt.

```
# we are saving the private key in our local jenkins_ci directory
./jenkins_key
```

Press enter twice when prompted for a passphrase. We will not use a passphrase for the Jenkins server user's keys.

Now you have two new files: a private key `jenkins_key` and a public key `jenkins_key.pub`. As with our previous keys, the private key should never be shared with anyone as it will allow them to access your server. The public key can be shared with anyone and does not need to be kept secret.

Execute the following command to create a new file with the new public key as an authorized key, which allows a private key to authenticate.

```
# the authorized_keys file will allow our server to grant SSH
# access to a connection using the private key
cp jenkins_key.pub authorized_keys
```

Obtain a new separate server on Linode. We provisioned our Linode production server all the way back in chapter 2 so you may want to review those steps if you run into trouble.

Secure the server with the `prod/fabfile.py` Fabric script from chapter 2. Copy the `fabfile.py` file and modify the values in the script with the new continuous integration server's IP address.

```
cp prod/fabfile.py jenkins_ci/fabfile.py
```

Edit the IP address found on line 21 of `fabfile.py` to the new Linode server's IP address.

```
env.hosts = ['192.168.1.1']
```

Edit line 35 in `fabfile.py` to specify a different key pair to upload to the server.

```
env.ssh_key_dir = '~/fsp-deployment-guide/jenkins_ci'
```

Modify line 77 in `fabfile.py` so the `jenkins_key.pub` file is uploaded instead of `prod_key.pub`.

```
'/jenkins_key.pub ' + env.ssh_key_dir + \
```

Run the copied Fabric file with the following command.

```
fab bootstrap
```

SSH into the continuous integration server with the new user. Again, make sure to replace the IP address seen here with the IP address of your new server.

```
ssh -i jenkins_key deployer@192.168.1.1
```

Our server is provisioned, locked down with a public-private key pair and we've logged in for the first time. Now we need to actually get Jenkins up and running on the server.

Ansible Automation Tweak

Before we install and configure Jenkins, we need to make a couple small tweaks to our Ansible playbook. Currently Ansible asks for the sudo password of the `deployer` user when we execute the playbook. However, our continuous integration server will not be able to respond to command prompts.

Modify the `prod/hosts` file with the `ansible_sudo_pass` argument after the IP address of the production server you're using to host your application.

```
192.168.1.1 ansible_sudo_pass="{{ deploy_user_password }}"
```

Add the following highlighted lines to the end of the `prod/group_vars/all` variables file.

```
# Chapter 3: Operating System (Ubuntu)
app_name: cyoa
deploy_user: deployer
deploy_group: deployers
## this is the local directory with the SSH keys and known_hosts
## file. do not include a trailing slash
ssh_dir: ~/fsp-deployment-guide/ssh_keys

# Chapter 4: Web Servers
## deploy_ssl true for HTTPS, false for only HTTP
deploy_ssl: false
wsgi_server_port: 8000
fqdn: cyoa.mattmakai.com
app_dir: /home/{{deploy_user}}/{{app_name}}
## local directory SSL certificates should be located here
## do not include a trailing slash
ssl_certs_dir: ~/fsp-deployment-guide/ssl_cert

# Chapter 5: Source Control
## directory where deploy_key was created and stored.
## do not include a trailing slash
local_deploy_key_dir: ~/fsp-deployment-guide/deploy_key
code_repository: ssh://git@github.com/mattmakai/choose-your-own-adventure-presentations.git

# Chapter 6: Databases
db_url: postgresql://{{deploy_user}}:{{db_password}}@localhost/{{app_name}}
## make sure to change this password to what you want your
## database password to be!
db_password: fortheloveofgodpleaseuseagoodpassword
db_name: "{{ app_name }}"
db_user: "{{ deploy_user }}"

# Chapter 7: Application Dependencies
```

```
venv_dir: "/home/{{ deploy_user }}/envs/{{ app_name }}"
venv_python: "{{venv_dir}}/bin/python"
wsgi_env_vars: {
    ## in production you'll likely want to set this to False
    DEBUG: True,
    ## make sure to set your own unique long secret key for your app
    SECRET_KEY: 'super secret key make sure to change this',
    DATABASE_URL: '{{ db_url }}',
    REDIS_SERVER: 'localhost',
    REDIS_PORT: 6379,
    REDIS_DB: 1,
    ## these next two environment variables are found in the
    ## Twilio account dashboard on twilio.com
    TWILIO_ACCOUNT_SID: 'found on the twilio dashboard',
    TWILIO_AUTH_TOKEN: 'also found on the twilio dashboard',
    ## grab a number on Twilio for the application and Ansible
    TWILIO_NUMBER: '+15551234567',
    CELERY_BROKER_URL: 'redis://localhost:6379/0',
    CELERY_RESULT_BACKEND: 'redis://localhost:6379/0',
}
## username you want to use to log into app's admin screen
app_admin_user: ''
## password you want to use to log into app's admin screen
app_admin_password: ''

# Chapter 8: WSGI Servers
## no new variables necessary for this chapter

# Chapter 9: Task queues
deployment_alert: true
## your phone number that should receive a deployment complete
## text message. example format: "+19735551234"
alert_number: ""

# Chapter 10: Continuous Integration`
## this grabs the sudo password for the deployer user`
## from an environment variable called REMOTE_DEPLOYER_PASSWORD`
{% raw %}
deploy_user_password: "{{ lookup('env', 'REMOTE_DEPLOYER_PASSWORD') }}"`
{% endraw %}
```

In the above Ansible variables file, we now pull the password from an environment variable instead of keeping it in the file itself. This is a much better security practice than keeping plaintext passwords in the variables file itself.

Test out the script locally by setting an environment variable with the password to the remote deployer user.

```
export REMOTE_DEPLOYER_PASSWORD='my super secret password'
```

If you are using the `deploy_prod.sh` shell script, remove the `-K` argument so the ansible-playbook command looks like the following:

```
#!/bin/bash
ansible-playbook ./prod/deploy.yml --private-key=\
./ssh_keys/prod_key -u deployer -i ./prod/hosts
```

With those minor tweaks in place, we can now continue installing and configuring our Jenkins CI server.

Install Jenkins System Package

Next we'll install the Jenkins package and handle the initial configuration.

Now that we are logged into the continuous integration server, make sure the necessary packages are installed.

```
sudo apt-get update
sudo apt-get install fail2ban git-core python-virtualenv python-dev
```

We need to install Jenkins, but the `jenkins` package is in a third party repository. The third party repository is not where official Ubuntu packages are kept, but we can add the hosted Jenkins repository to our system so that Jenkins can be installed using `apt` just as with other packages we've installed.

```
wget -q -O - https://pkg.jenkins-ci.org/debian/jenkins-ci.org.key | \
sudo apt-key add -
```

Add the new package repository into the system's `source.list` file.

```
sudo add-apt-repository "deb http://pkg.jenkins-ci.org/debian binary/"
```

Update the available packages list and install the `jenkins` package.

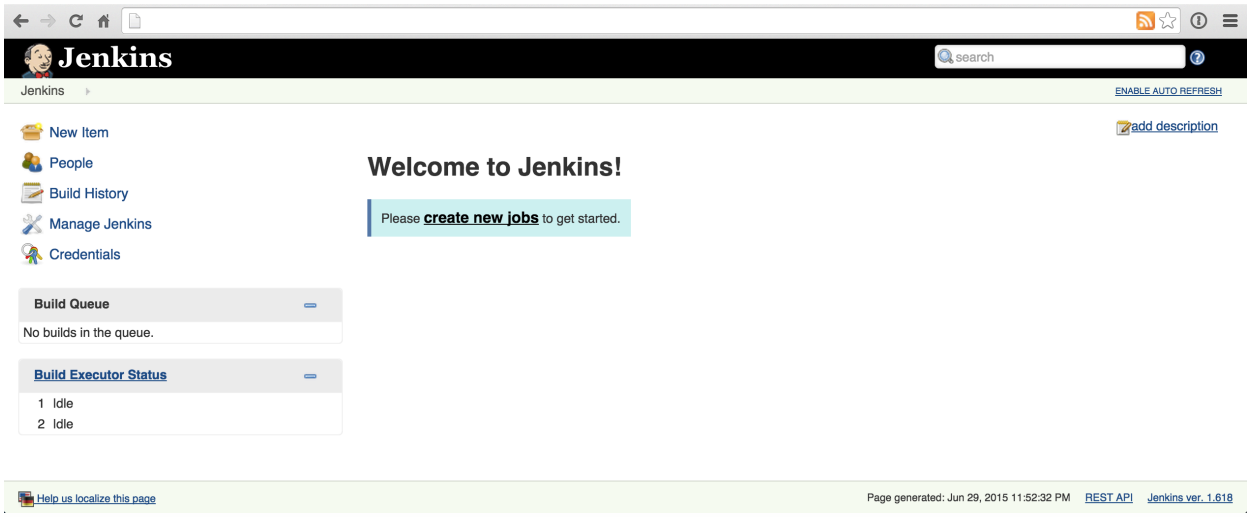
```
sudo apt-get update
sudo apt-get install jenkins
```

Once the package installations finish start up Jenkins as a system service.

```
sudo service jenkins start
```

Head to your server's IP address plus the port number 8080 in the browser. For example, if your Linode's IP address is 192.168.1.1, go to http://192.168.1.1:8080/.

You should see a screen like this one.

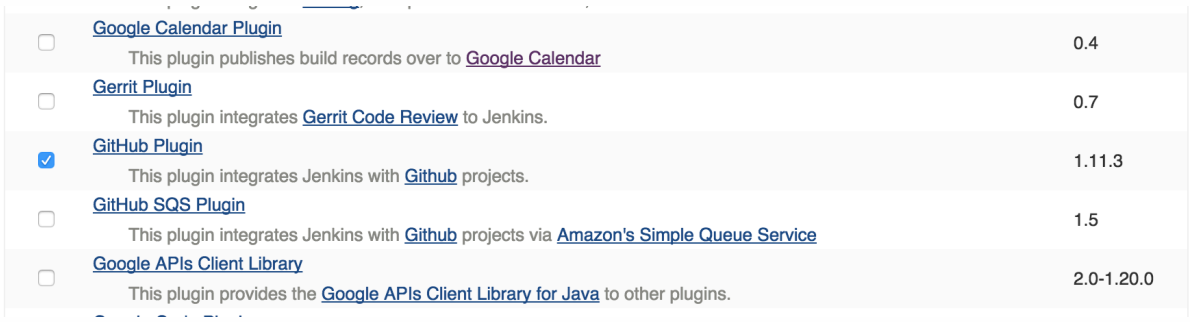


There is a massive problem with this screen though - if you can see it, so can anyone else! We need to secure the installation so only you can use Jenkins.

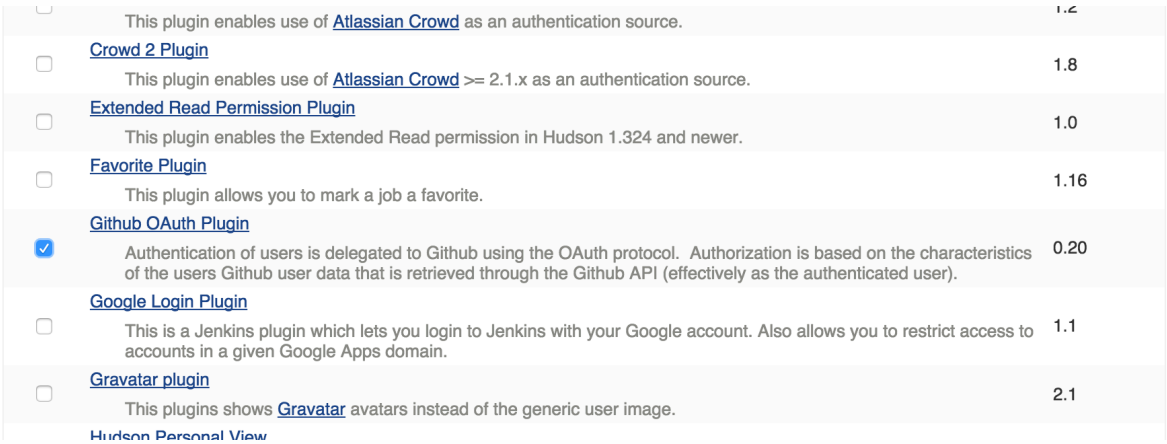
Secure Jenkins

Jenkins is open to the whole world until we secure it. We will handle those steps now with a combination of command-line configuration and modifying settings in the Jenkins user interface.

Add the GitHub plugin.

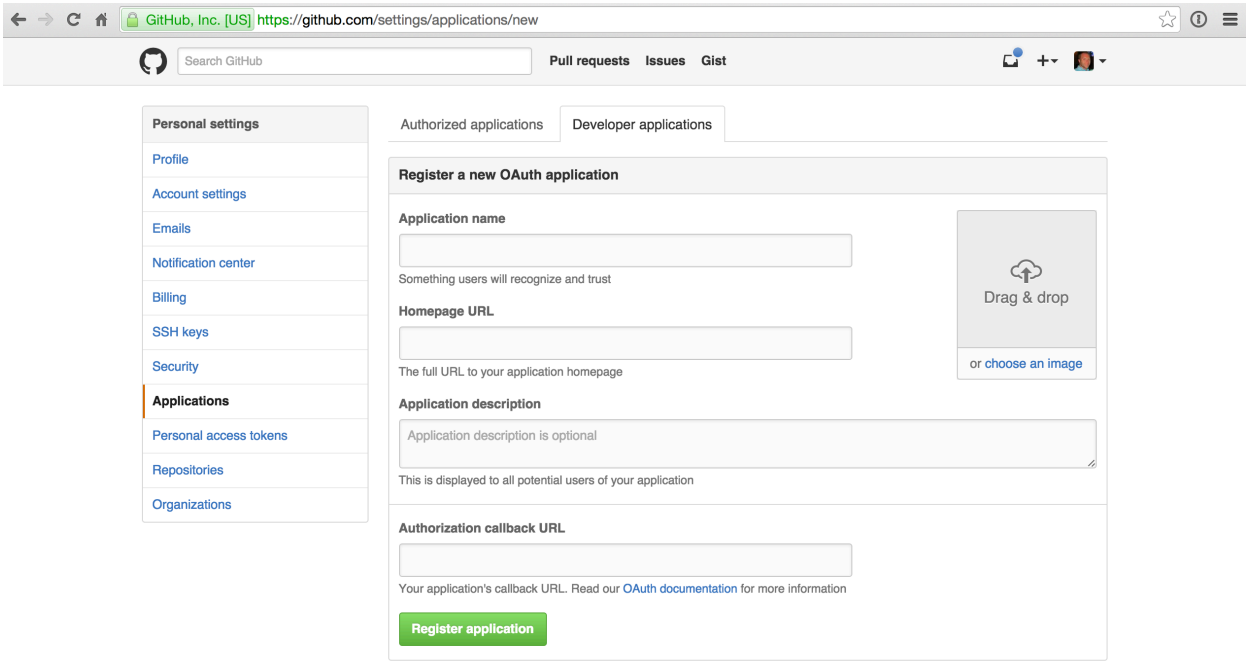


Add the Github Authentication Plugin (named the "GitHub OAuth" plugin in previous versions).

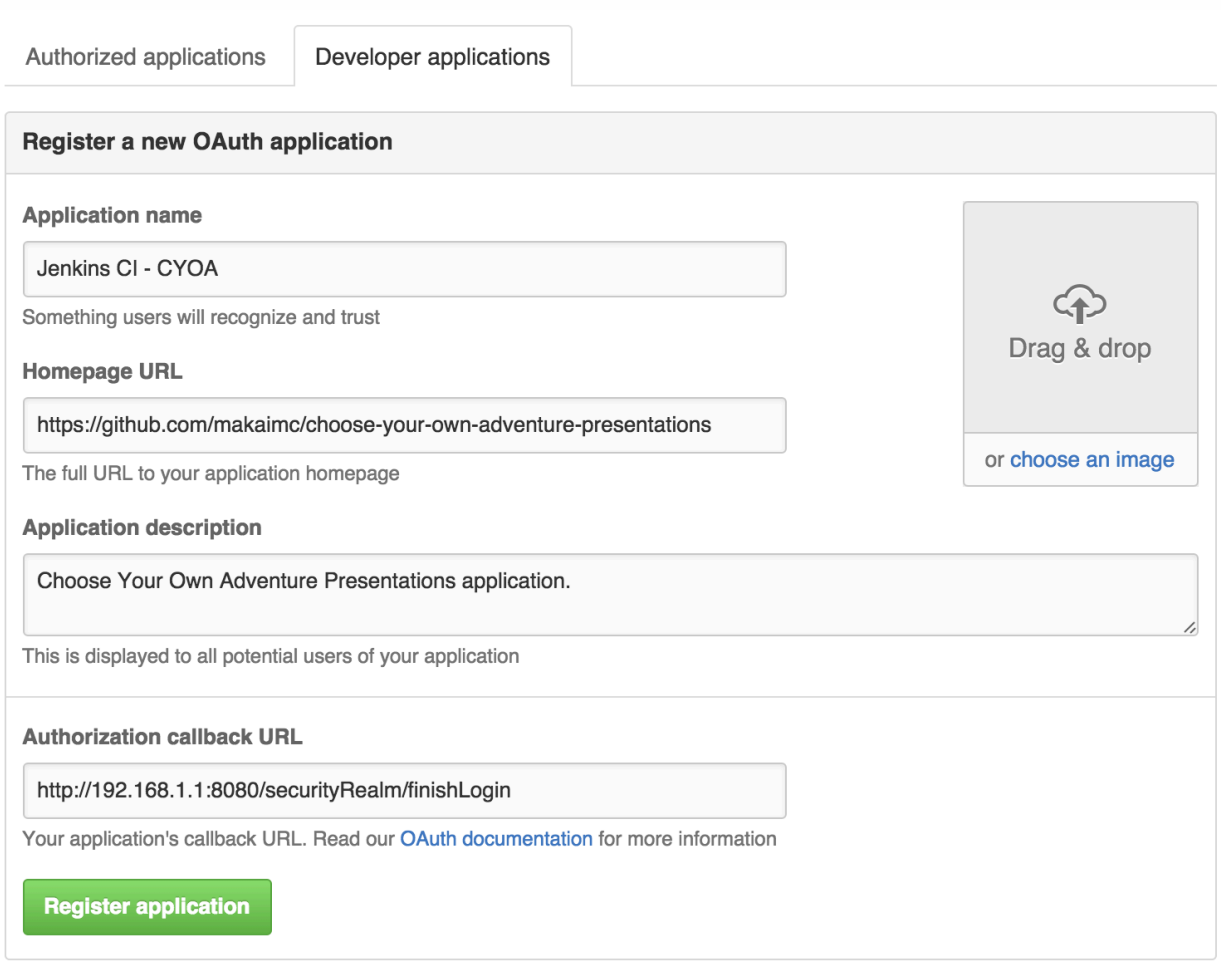


Install the plugins and click to allow Jenkins to restart.

While waiting for Jenkins to restart, go to https://github.com/settings/applications/new on GitHub.

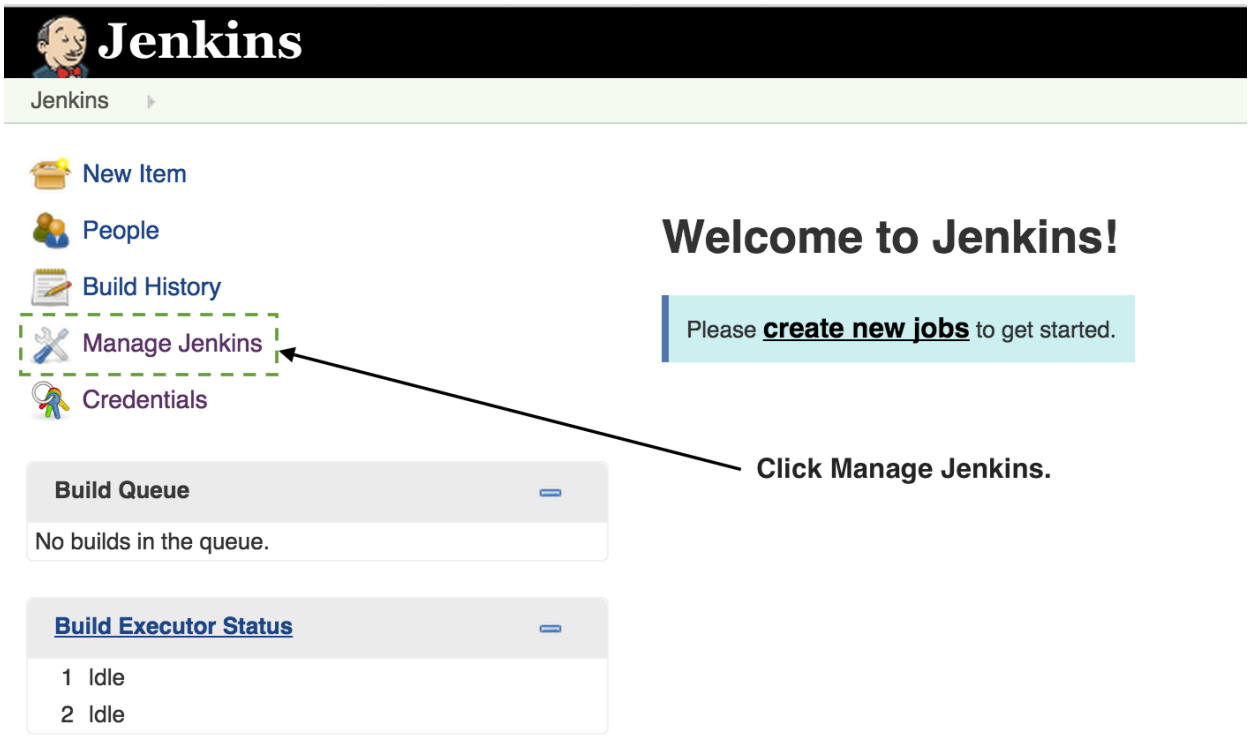


Set up a new application for Jenkins on the GitHub screen. Fill in http://192.168.1.1:8080/securityRealm/finishLogin under the Authorization callback URL, where `192.168.1.1` is replaced with your Jenkins server IP address.

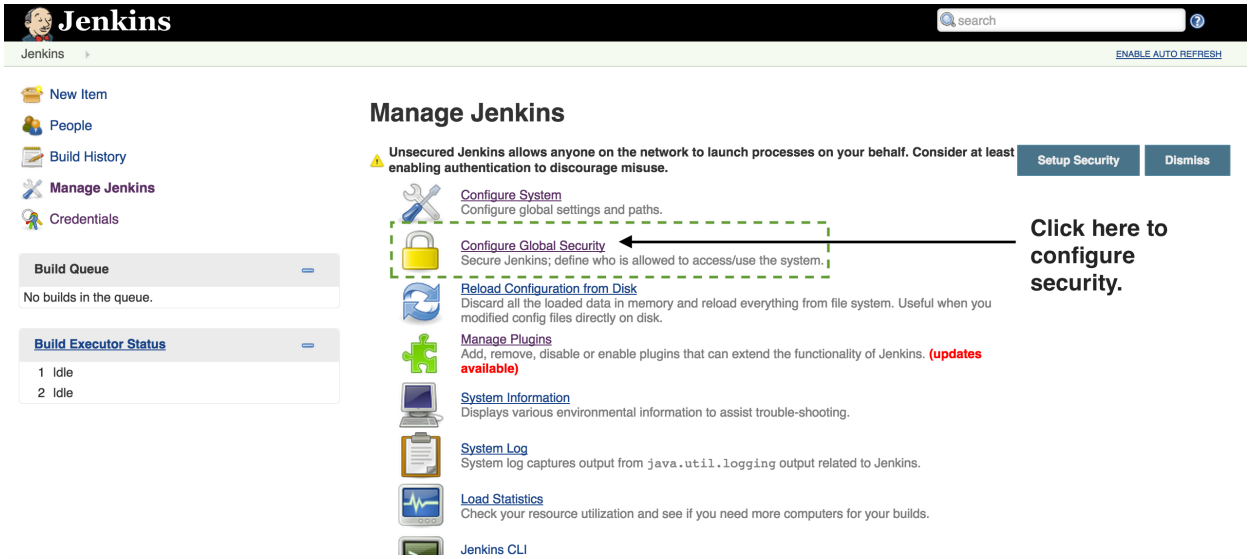


Move back over to the Jenkins web application now that it is restarted with the new plugins.

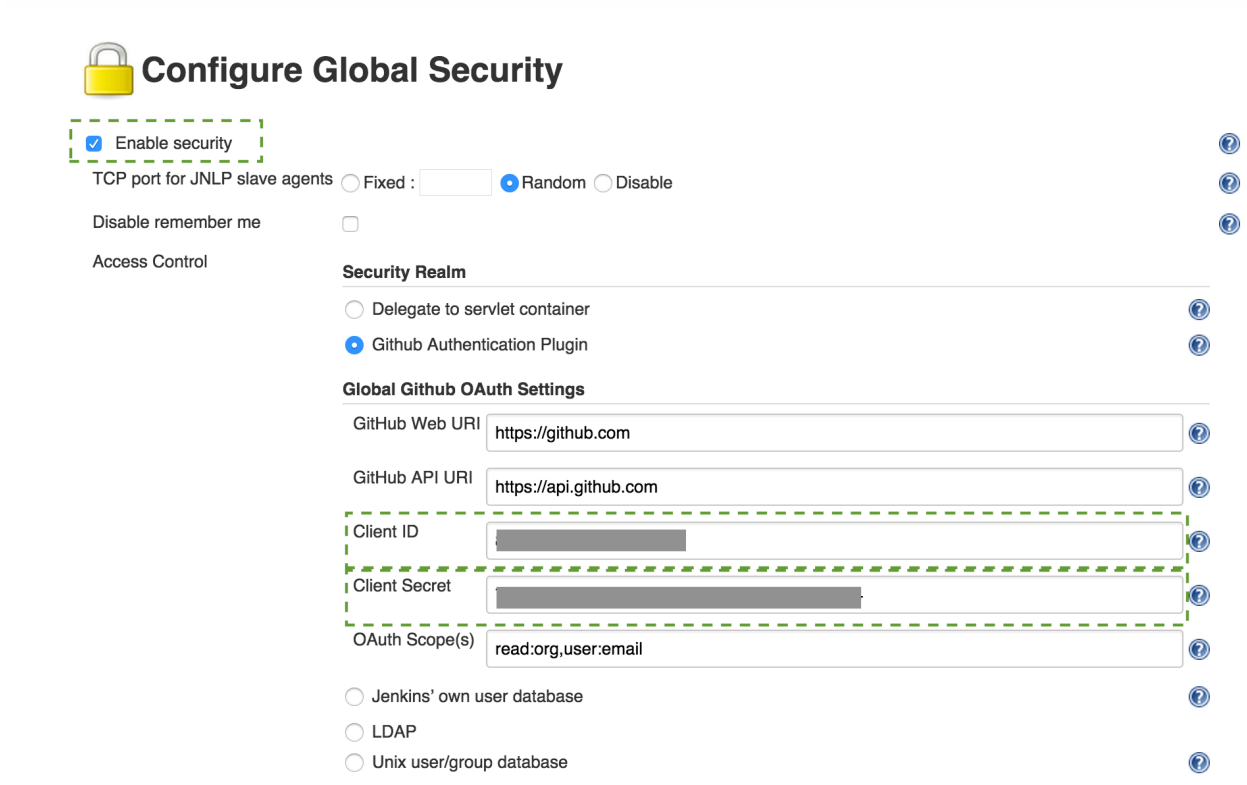
Click "Manage Jenkins".



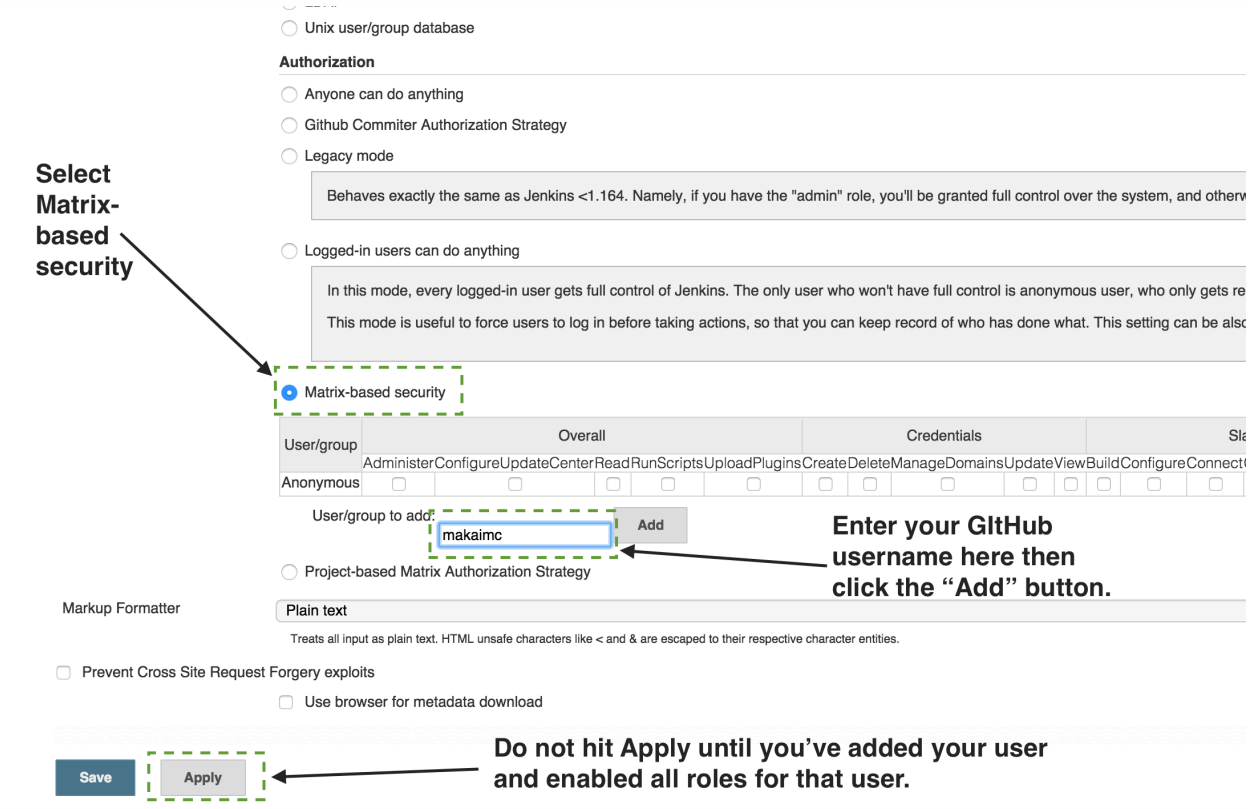
Click "Configure Global Security".

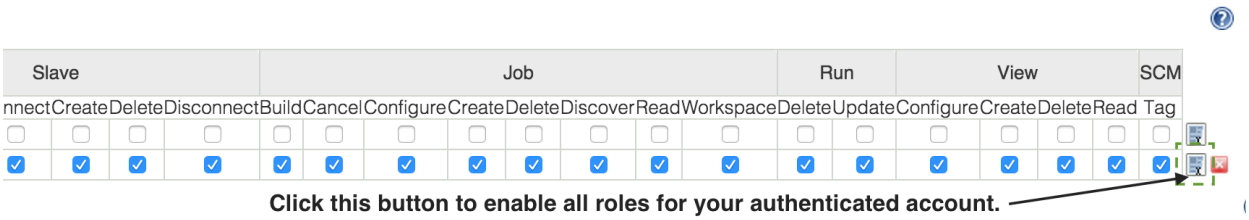


Check "Enable Security", then enter the credentials GitHub generated for you when you created an application for Jenkins CI.



Select "Matrix-based Security", enter your GitHub username, click Add, select all permissions for your username but none for Anonymous, then click Apply.





Log in and out of Jenkins to confirm that a logged out user cannot access anything inside the application and is simply redirected to GitHub to determine if she should have access to this Jenkins CI user interface.

Create CI Deploy Key

We need to create one more deploy key separate from the production server deploy key and the other private keys we use to log into the server. This deploy key will grant read-only access from the Jenkins server to the forked repository that we want to use the commands `git clone` and `git pull` to grab our application's code.

Run the `ssh` command from your local machine to log back into the Jenkins CI server. Again, make sure to replace the IP address seen here with the IP address of your new server.

```
ssh -i jenkins_key deployer@192.168.1.1
```

Once logged into the CI server, change over to the `jenkins` user.

```
sudo su -s /bin/bash jenkins
```

Go to the `jenkins` user home directory.

```
cd ~
```

On the remote server create a new directory for our SSH keys. If the directory already exists you can ignore the error message.

```
mkdir ~/.ssh
```

Create a new public-private key pair to use as deploy keys.

```
ssh-keygen -t rsa -b 2048
```

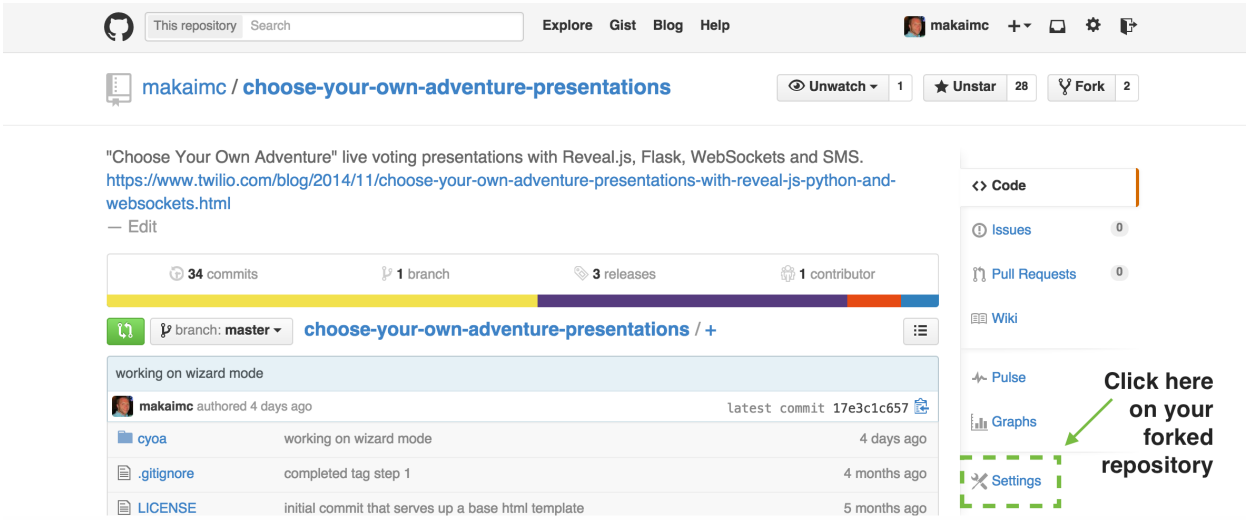
When prompted for a file in which to save the keys you can use the default values.

Press enter twice when prompted for a passphrase. We won't use a passphrase on the deploy key.

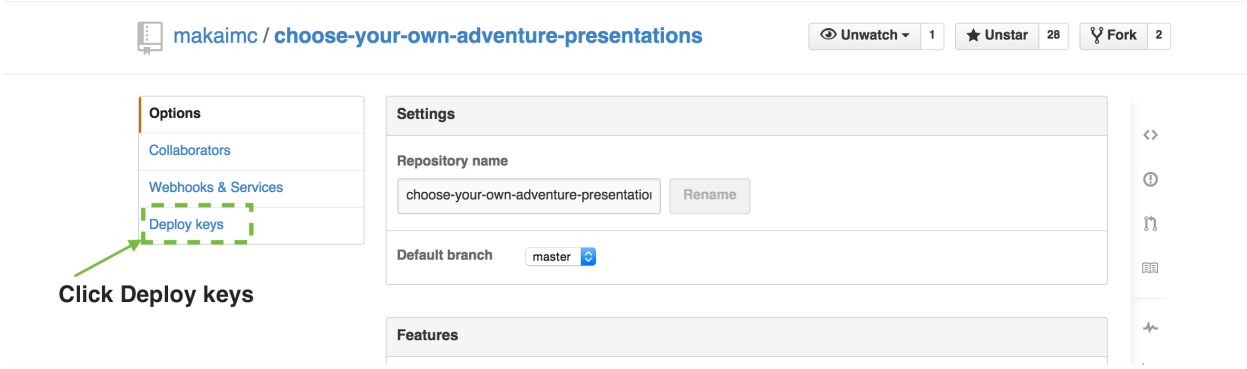
Now you again have two new files: a private key `id_rsa` and a public key `id_rsa.pub`. We just need to put the public key into GitHub so they function as deploy keys.

Go to your forked Choose Your Own Adventures Presentations repository page on GitHub.

Click the settings link on the right navigation bar within your forked repository's page.



Click "Deploy Keys" on the left navigation bar.



Press the "Add deploy key" button.

Two text boxes will appear on the screen. Fill in a title and the contents of the `id_rsa.pub` key file you just created. Make sure you use the `id_rsa.pub`

file, not the private key stored in `id_rsa`. Do not allow write access since we won't need that for Jenkins right now.

Press the "Add Key" button. Now you're all set to clone this forked repository's code onto your production server.

Back on the server as the Jenkins user, let's test out our deploy key. Execute the following command and specify 'yes' if it asks you to verify the host signature.

```
git ls-remote -h \
ssh://git@github.com/mattmakai/choose-your-own-adventure-presentations.git HEAD
```

Next we need to load our Ansible playbook onto the Jenkins CI server so that the `jenkins` user can access them. There are a couple of ways to do this.

The first option is to use the secure copy command from your local machine to put the automation files onto the server. For example, you can `tar` up your local Ansible playbook then `scp` it to the server with the following commands. Run these commands from your local machine and make sure to replace the IP address with the IP address of your Jenkins machine.

```
tar -cvf deploy.tar ~/fsp-deployment-guide
scp -i ~/fsp-deployment-guide/jenkins_ci/jenkins_key deploy.tar deployer@192.168.1.2:~
```

Then copy those files from the `deployer` user's home directory into the `~` (home directory) of the jenkins user and use the following command to untar the files.

```
tar -xvf deploy.tar.gz
```

The other option is to clone the Ansible playbook automated deployment repository. For example, if you want to use the default Ansible playbook you'd clone the following repository. **Important note:** you will have to enter your own values into the configuration and ensure you have the appropriate SSH keys to get this repository to automate your deployments.

```
git clone git@github.com:mattmakai/fsp-deployment-guide
```

When you get the Ansible playbook on the continuous integration server, continue on with these steps to test the playbook out. Create a virtualenv for

the Jenkins account so it can use Fabric and Ansible to perform the deployment.

```
virtualenv cyoa
source cyoa/bin/activate
pip install Fabric==1.10.2 Ansible==1.9.2
```

Test out the Ansible playbook while logged into the `jenkins` user. For testing purposes, export the `REMOTE_DEPLOYER_PASSWORD` variable, which is the sudo password for the deployer user on the production server, so that the updated Ansible playbook can pick it up.

```
cd ~/fsp-deployment-guide
export REMOTE_DEPLOYER_PASSWORD='remote deployer password'
./deploy_prod
```

Enter the sudo password of the remote `deployer` user for the server you are performing the deployment on.

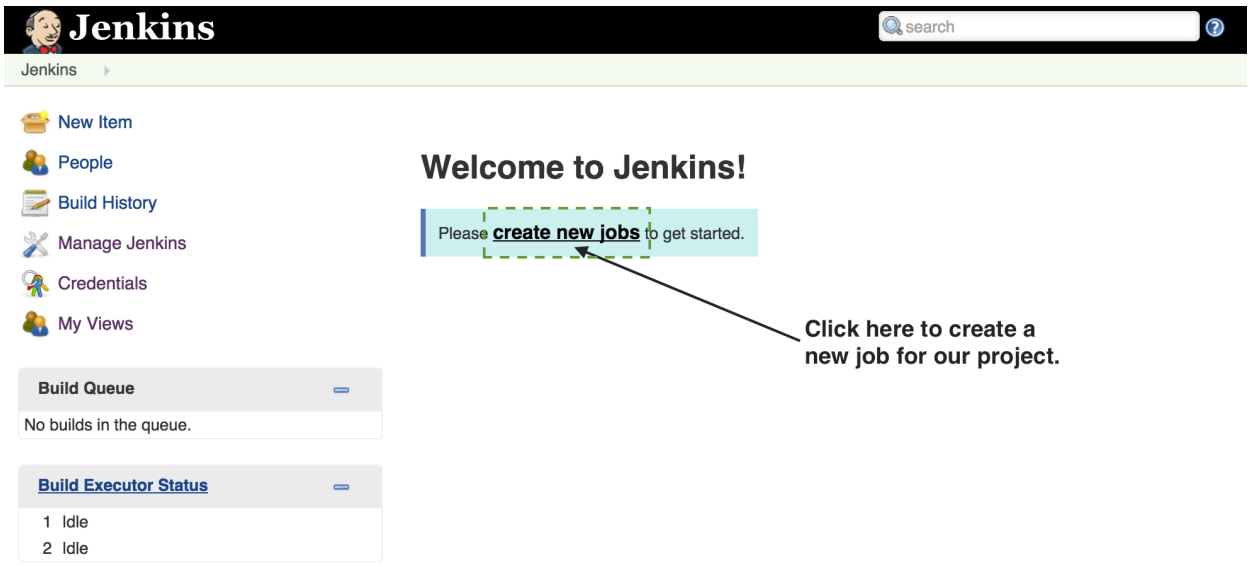
A message like the following one will likely pop up, only with your production server's IP address instead of the one shown in here. Enter 'yes' and press enter so the deployment can proceed.

```
The authenticity of host '66.175.209.129 (66.175.209.129)' can't be established.
ECDSA key fingerprint is 7a:2a:d0:4c:62:5e:19:e9:ee:48:7b:f2:70:f9:05:c7.
Are you sure you want to continue connecting (yes/no)? yes
ok: [66.175.209.129]
```

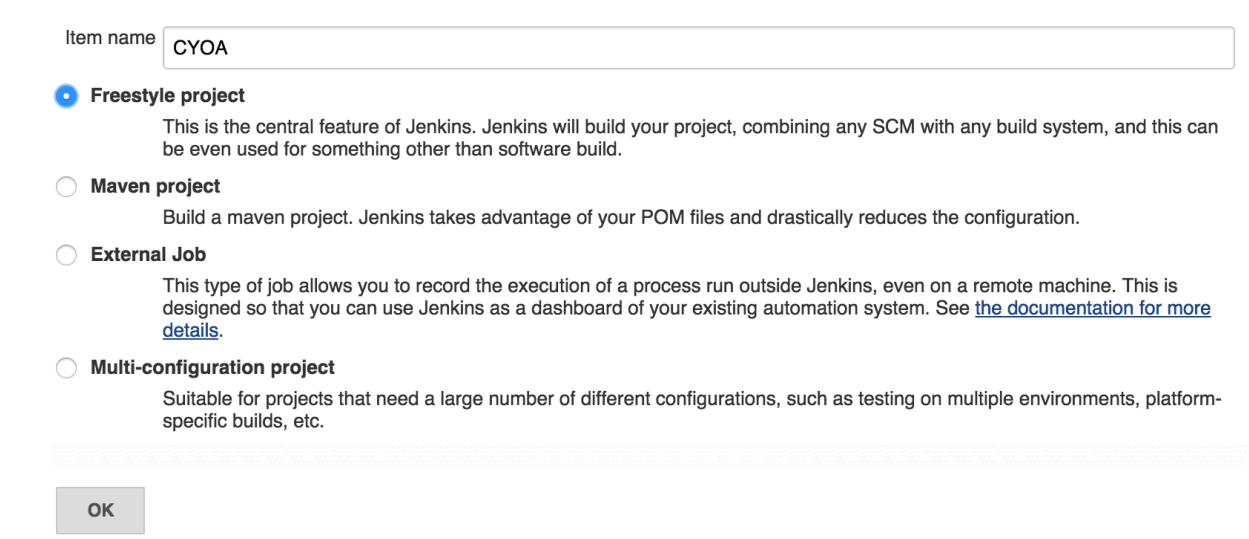
Configure Jenkins Build Job

We need to configure Jenkins through the user interface so that it pulls the project from GitHub and kicks off the Ansible deployment.

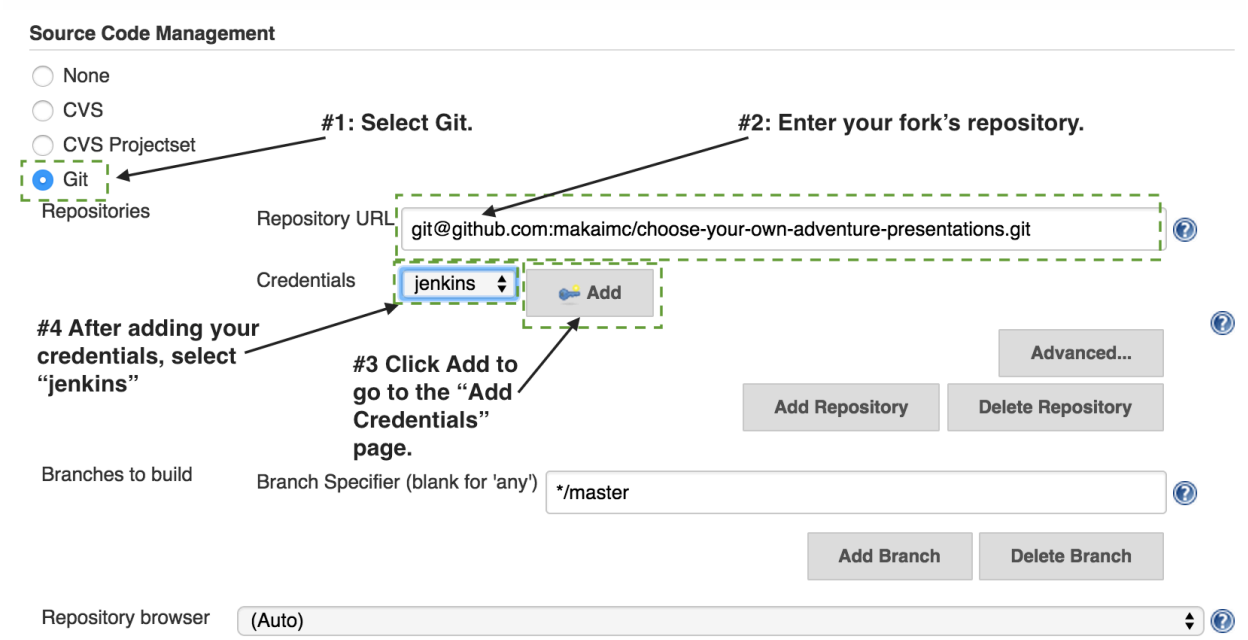
Click "Create New Job" on Jenkins' main dashboard page.

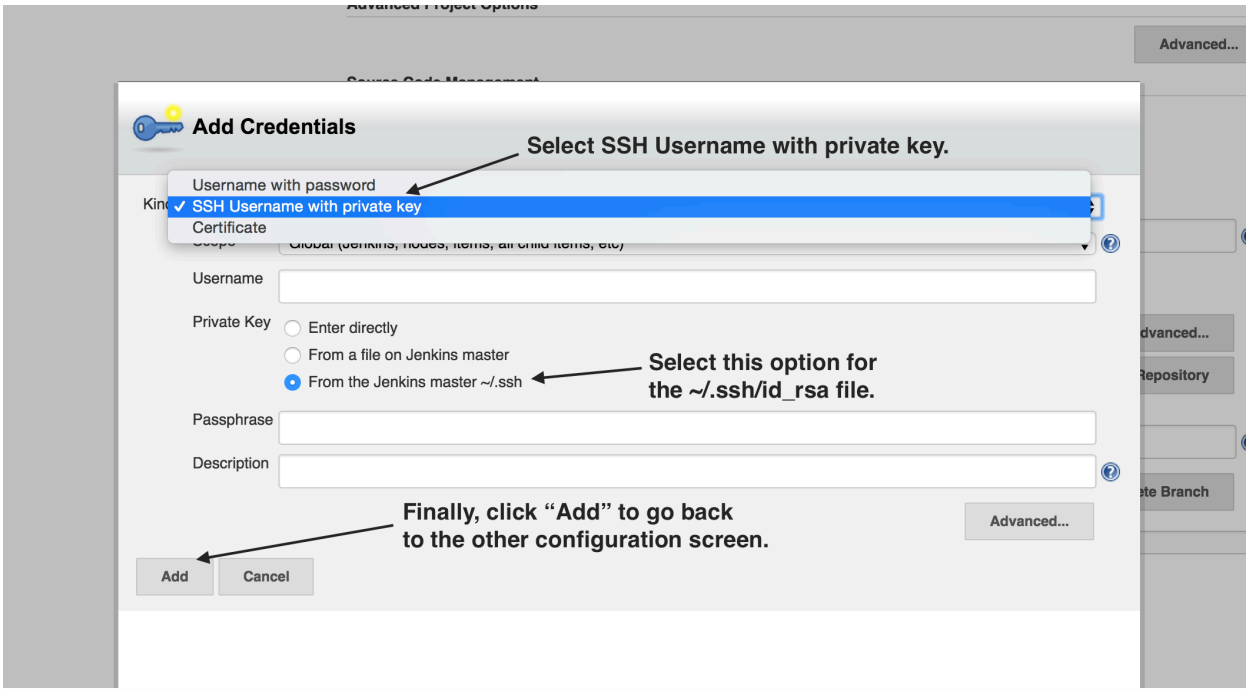


Name it "CYOA" and select "Freestyle Project", then click the "OK" button.



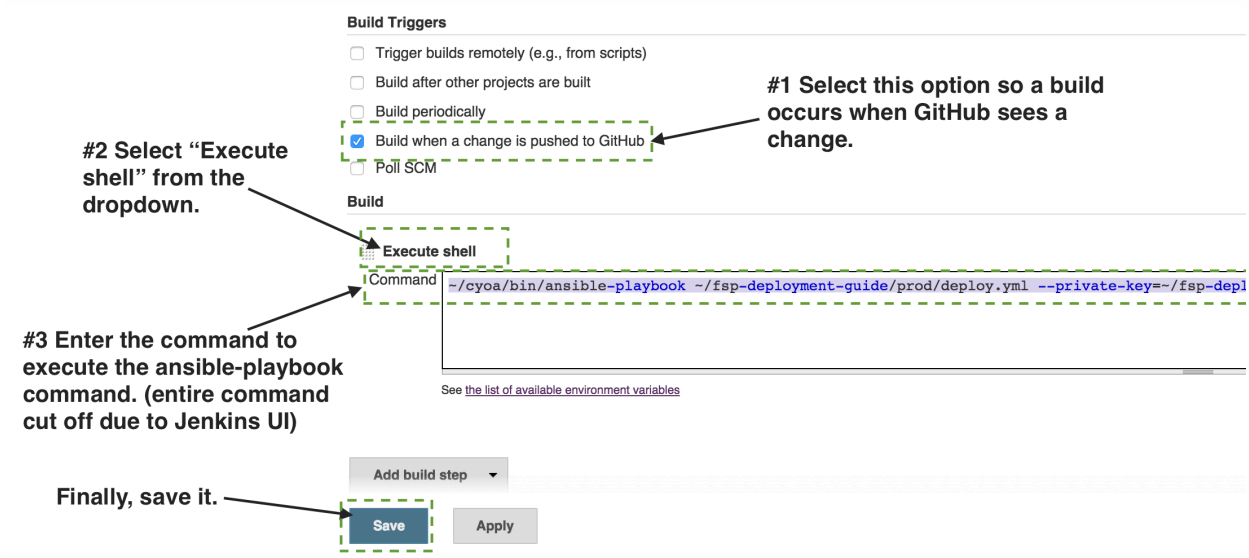
Under the "Source Code Management" section, select "Git" project and add your credentials that were configured on the command line.





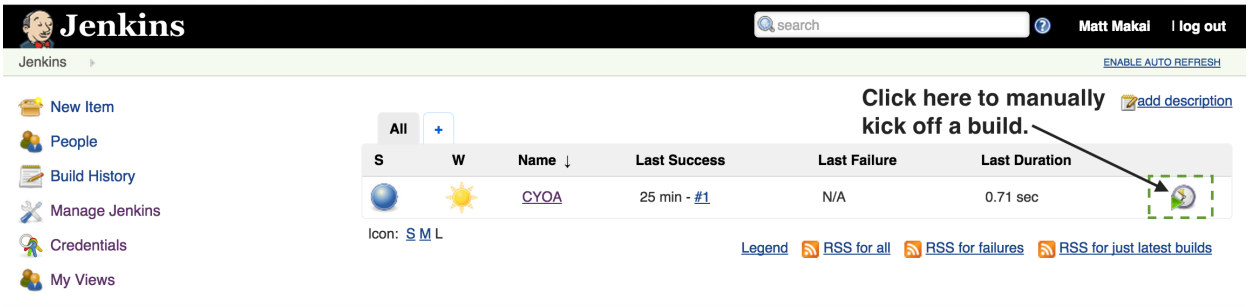
Select "Execute shell" and enter the following command on a single line:

```
export REMOTE_DEPLOYER_PASSWORD='remote deployer password'; ~/cyoa/bin/ansible-playbook ~/fsp-deployment-guide/prod/deploy.yml --private-key=~/fsp-deployment-guide/ssh_keys/prod_key -u deployer -i ~/fsp-deployment-guide/prod/hosts
```

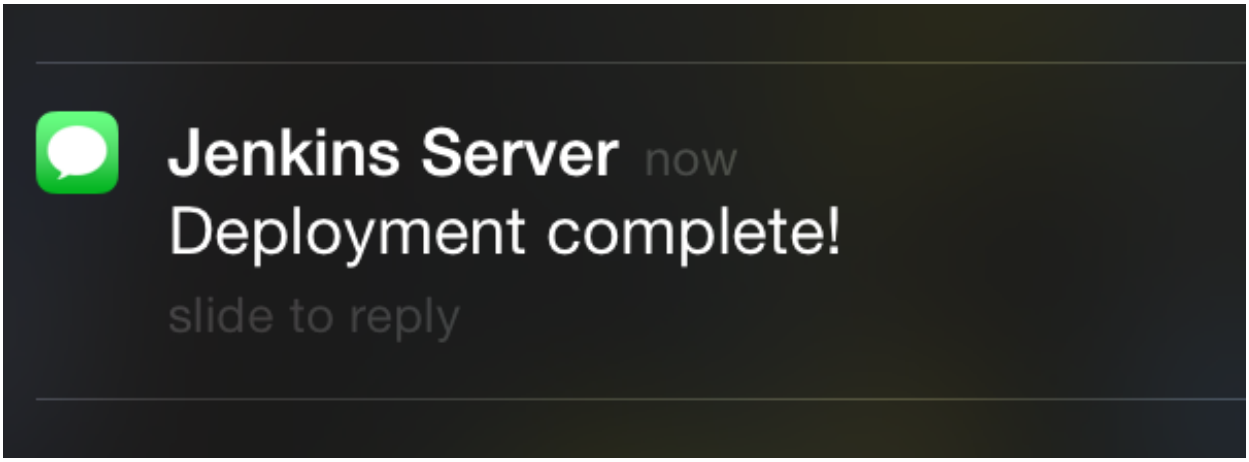


Click Save and the project settings will immediately take effect.

We've set up the initial settings for the project including pulling the code from the remote GitHub repository onto our server with a new deploy key. Let's test it manually now. Click the build button on the dashboard to kick off a new build.



If the build is successful, you'll receive a text message a bit later that tells you the deployment is complete!



Go Ahead, Push Some New Code

Modify some code in your local project, commit the code to the local repository and push it to the remote repository on GitHub. GitHub will then send a service hook HTTP POST request to your Jenkins server that will kick off a build.

Woohoo! Full service automated deployment by the Jenkins continuous integration server is complete!

Next Steps

Note that Jenkins is only running over HTTP right now - your interactions are not encrypted. There's more security work that needs to be done to lock Jenkins down. The next step you should take is to secure Jenkins behind a reverse proxy that uses HTTPS as we do with our WSGI server that runs our Python web application.

If a full Jenkins security tutorial is something you'd like to see as part of this guide, send me an email at matthew.makai@gmail.com, create a pull request on the fsp-deployment-guide repository on GitHub. There are many directions this book can continue to expand into and your feedback is valuable for making sure the right content is written to help our Python community.

For more future directions, continue reading into the next chapter, "What's Next?".

More Continuous Integration Resources

The CI setup we created in this chapter is just the beginning for deployment automation. These articles should give you further insight into CI and where you could take your infrastructure from here.

- What is continuous integration? is a classic article by Martin Fowler on CI concepts and implementations.
- Continuous Deployment For Practical People provides a broad overview of the subject.

- Continuous Integration & Delivery - Illustrated uses well done drawings to show how continuous integration and delivery works for testing and managing data.
- Diving into continuous integration as a newbie is a retrospective from a Rackspace intern on what she learned about CI from her experience.
- Thoughts on web application deployment walks through stages of deployment using source control, planning, continuous deployment and monitoring.
- Practical continuous deployment defines delivery versus deployment and walks through a continuous deployment workflow.

Other Open Source CI Projects

If Jenkins CI server isn't your jam, here is a list of other continuous integration servers that you could also try for your deployment needs.

- Go CD is a CI server by ThoughtWorks designed with build pipelines and test & release cycles in mind. The Go CD source code is available on GitHub.
- Strider is a CI server written in node.js.
- BuildBot is a continuous integration **framework** with a set of components for creating your own CI server. It's written in Python and intended for development teams that want more control over their build and deployment pipeline. The BuildBot source code is also on GitHub.

Hosted CI Services

If you want to skip setting up your own continuous integration server, take a look at the following hosted CI services. They make setting up CI on one or more projects easier than deploying your own Jenkins instance, but for some projects the monthly fees may be prohibitive depending on your budget.

- Travis CI provides free CI for open source projects and has a commercial version for private repositories.

- Bamboo is Atlassian's hosted continuous integration that is also free for open source projects.
- Circle CI works with open or closed source projects on GitHub and can deploy them to Heroku if builds are successful.
- Shippable uses Docker containers to speed the build and integration process. The service is free for public repositories.
- Codeship provides continuous integration for Python versions 2.7 and 3.4.

Chapter 11

What's Next?

What's Next?

Our deployment is now automated and runs continuously whenever code is committed and pushed into the remote Git repository. However, there are many enhancements we could make to this deployment process.

Most large-scale web application deployments use a suite of further techniques that increase the capabilities of their infrastructure. This chapter is intended as a "future directions" collection of ideas that you may want to take in your own deployment. I will also add additional chapters to this book on any of these topics based on reader feedback.

Deployment Enhancements

Our deployment process right now is simple - it will get your application out of source control and onto a server that can execute the Python code. Yet there are a whole bunch of ways to make it better by incorporating additional steps into the Ansible playbook. Here is a list of potential concepts to research and consider adding to our deployment:

- Add test servers before deploying to production
- Allow source code roll backs after a bad deployment
- Incorporate unit and integration tests into the build process
- Rotate the public-private key pairs for additional security
- Back up the server on a regular schedule
- Deploy through a system package instead of version control

Improving Performance

There are numerous ways the web application's performance can be improved by modifying the server configuration. Here are several possibilities for scaling up server and application performance:

- Resize up the Linode virtual private server
- Split the application and database servers
- Incorporate load balancers with multiple web servers
- Serve static assets from a content delivery network (CDN)
- Replicate the database to a read-only copy

Onward!

Those are just a few of the options for improving the deployment process and upgrading the application's performance. What content would you like to see added to the book? Send me an email at matthew.makai@gmail.com or tweet me @mattmakai or @fullstackpython to let me know what you think. All updates to this book will be available for free to current purchasers, so your opinion is meaningful in determining how the content grows over time!

Appendix A

Glossary

Appendix A: Glossary

This glossary provides plain language definitions of the concepts found throughout this book. If you are uncertain about what a word or concept means, this glossary plus the additional information provided on Full Stack Python should clear up the confusion. If it does not, email me and I will make sure to clarify the concepts in future version of this book.

Application dependencies

Application dependencies are the libraries other than your own project code that are required to create and run your application. These dependencies are referenced in a `requirements.txt` file, retrieved from PyPI via the `pip` command and installed into a `virtualenv` to isolate the dependencies from other projects' dependencies.

Continuous integration

Continuous integration is the concept of building and testing code after every change a developer commits and pushes into version control. The theory is that if disparate parts of a project's code are not integrated together until the end of the project, then the integration period will be painful due to bugs that occur during interactions between software components. Continuous integration server implementations include Jenkins, TeamCity and Go.

Deployment

A *deployment* is the process of packaging up an application's code and putting it on a server where it can be run for users. Some deployments are just to a development server for fellow developers to test their code, while other deployments go to a test server to make sure the code works properly. The last stage in a deployment is usually to one or more production servers that host the canonical version of an application.

Flask

Flask is a Python web framework created with a small core and easy-to-extend philosophy. Flask pieces together several open source projects, including

Werkzeug, Jinja2 and SQLAlchemy (for relational database object-relational mapping) to make it easier to build WSGI-compatible web applications with the framework. Flask is the web framework used by the Choose Your Own Adventure Presentations example application deployed throughout this book.

NoSQL

NoSQL, also referred to as *Not Only SQL*, is a database type that forgoes one or more constraints present in traditional relational databases. The tradeoff is done to gain some other attribute - often better speed in read or write access. There are many types of NoSQL database implementations, including Redis, MongoDB, Cassandra and HBase.

pip

Pip is a tool used to install Python packages from one location, often a remote dependency management server such as PyPI or GitHub, into a local Python installation directory. Pip is often used with a `requirements.txt` file so the appropriate application dependencies versions for an application can be installed.

PostgreSQL

PostgreSQL is an open source relational database implementation. In this book, PostgreSQL is the primary data storage backend for the application.

Production server

A *production server* or *production environment* hosts the canonical version of the running code for your application. There can be many environments for development and testing, but production is the only one that contains the live version of your application.

PyPI

The *Python Package Index*, also known as *PyPI* or the "CheeseShop", is a central remote service that contains numerous versions of application dependencies for Python packages that were uploaded by their authors. For example, the Flask web microframework is stored on PyPI and can be

retrieved to a local computer by using the `pip` command. PyPI is often just called "the CheeseShop" to differentiate it from the PyPy project, which is a separate concept not covered in this book.

Source control

Source control, also known as *version control*, stores software code files with a detailed history of every modification made to those files. Source control systems allow developers to modify code without worrying about permanently screwing something up. Unwanted changes can be easily rolled back to previous working versions of the code, which makes developing in both individual and team environments easier. Examples of source control implementations include Git, Mercurial and Subversion.

Task queue

A *task queue* is a concept for software that executes work in the background outside the HTTP request-response cycle of a web application. The work performed by a task queue would often take too long to process when a HTTP request came in or would need to be performed on a regular interval instead of being initiated by HTTP requests. Python task queue implementations include Celery, RQ and Taskmaster.

virtualenv

Virtualenv provides dependency isolation for Python projects. The virtualenv creates a separate copy of the Python installation that is clean of existing code libraries and provides a directory for new application dependencies on a per-project basis (a programmer can technically use a virtualenv for many projects at once but that is not considered to be a good practice).

Web framework

Web frameworks are code libraries that make it easier to build web applications. Web frameworks take care of common web development issues, such as HTTP requests and responses, URL routing, authentication, data handling and manipulation, sessions and security. The web framework implementation in this book is *Flask*. Other common Python-based web frameworks include Django, Bottle, Pyramid and Morepath.

Web server

A *web server* is an application that receives and responds to Hypertext Transport Protocol (HTTP) requests. The web server implementation used in this book is Nginx. Nginx serves static and provides a reverse proxy, which is an intermediate handler between a web client and the WSGI server running our web application. Other examples of web server implementations include the Apache HTTP Server, Caddy.

WSGI

Web Server Gateway Interface (WSGI) is a standard interface between Python applications and servers that execute the Python code. The interface was created to promote web application portability between different WSGI server implementations such as Green Unicorn, uWSGI, wsgiref and mod_wsgi.

Appendix B

More Python Resources

Appendix B: More Python Resources

This appendix wraps up the book with a collection of the best Python resources I have found. Many of these resources are free and the ones that cost money are well worth the investment to purchase them.

This chapter aggregates the best Python resources with a brief description of why it is useful.

New to Programming

If you're learning your first programming language these books were written with you in mind. Developers learning Python as a second or later language should skip down to the "experienced developers" section.

- To get an introduction to both Python and Django at the same time, consider purchasing Real Python by Fletcher, Michael, and Jeremy.
- Python for You and Me is an online book for people unfamiliar with the Python programming language.
- There's a Udacity course by one of the creators of Reddit that shows how to use Python to build a blog. It's a great introduction to web development concepts through coding.
- The O'Reilly book Think Python: How to Think Like a Computer Scientist is available in HTML form for free on the web.

Experienced Developers New to Python

People with prior software development experience will have an easier time learning the Python language than those who've never programmed before. In those cases it makes sense to use resources that spend less words on computer science fundamentals and more effort on explaining the specifics of the Python syntax. The following resources do a good job of teaching Python to those who already program in other other languages.

- Learn Python in Y minutes provides a whirlwind tour of the Python language. The guide is especially useful if you're coming in with previous software development experience and want to quickly grasp how the language is structured.
- The Hitchhiker's Guide to Python contains a wealth of community-curated information both on the Python language and the ecosystem around it.
- Google's Python Class has lecture videos and exercises for learning Python.

Beyond the Basics

Whether you're a newcomer to programming or a grizzled veteran, there's always room for you to grow and more to learn after grasping the Python syntax. The following resources are useful for understanding the broader ecosystem and more advanced subjects.

- The Python Subreddit and Learn Python Subreddit roll up great Python links and have an active community ready to answer questions from beginners and advanced Python developers alike.
- Good to Great Python Reads is a collection of intermediate and advanced Python articles around the web focused on nuances and details of the language itself.
- The blog Free Python Tips provides posts on Python topics as well as news for the Python ecosystem.

Videos, Screencasts and Presentations

If you prefer to watch videos and screencasts instead of reading through more text, these are some great resources for you to learn more about Python.

- Kate Heddleston gave a talk at PyCon 2014 called "Full-stack Python Web Applications" with fun visuals for how numerous layers of the Python web stack fit together. There are also slides available from the talk with all the diagrams.

- My "Full Stack Python" talk at EuroPython 2014 goes over many concepts from the Full Stack Python website with context for how the pieces fit together. The talk slides are also available.
- PyVideo organizes and indexes thousands of Python videos from both major conferences and meetups.

Newsletters

Email newsletters are good for keeping up with the latest open source projects and articles. Rather than you having to spend your time searching the web for these helpful resources, you can have someone else aggregate them for you and deliver to your inbox.

- Python Weekly provides a free weekly roundup of the latest Python articles, videos, projects and upcoming events.
- PyCoder's Weekly is another great free weekly email newsletter similar to Python Weekly. The best resources are generally covered in both newsletters but they often cover different articles and projects from around the web.
- Import Python is a newer newsletter thank Python Weekly and PyCoder's Weekly. So far I've found this newsletter covers different sources from other newsletters. It is well worth subscribing to all of them so you don't miss anything.
- The Full Stack Python monthly newsletter is a monthly newsletter that focuses on a single topic each month. For example, one month will aggregate great Flask resources, while another month will provide WSGI server configurations.

Appendix C

App Code Tutorial

Appendix C: Sample App Tutorial

This chapter is a streamlined version of the original code tutorial for the example application we deployed in this book. This Choose Your Own Adventure Presentations Flask web app provides a reasonable example for deployment because it is open source and relies on many widely used web application technologies such as PostgreSQL, Redis, Celery, WebSockets and Green Unicorn.

Going through this appendix is not required to do the deployment in this book. It is included since I wrote the original posts for the Twilio blog.

Note that this tutorial will take you up to the tutorial-step-6 tag but I kept working on the project so for this book you should use the master branch for the deployment.

Choose Your Own Adventure Presentations with Reveal.js, Python and WebSockets

You're preparing a technical talk on your new favorite open source project to present to your local software meetup group.

———

How do you proceed? If you choose to create another passe linear slide deck, load up Microsoft PowerPoint. If you decide to build a childhood nostalgia-packed Choose Your Own Adventure presentation, continue reading this tutorial.

———

Good choice! To create our Choose Your Own Adventure presentation we'll use Reveal.js, Flask, WebSockets and Twilio SMS. Our final product will have decision screens like the following screenshot where SMS votes from the audience are counted and displayed in real-time to determine the next step in the presentation story. Once the votes are tallied the presenter can click the left choice or the right choice to go to the appropriate next slide in the presentation.

Take a look at the DjangoCon US 2014 "Choose Your Own Django Deployment Adventure" video if you want to see an example of a Choose Your Own Adventure presentation in action.

Tools We Need

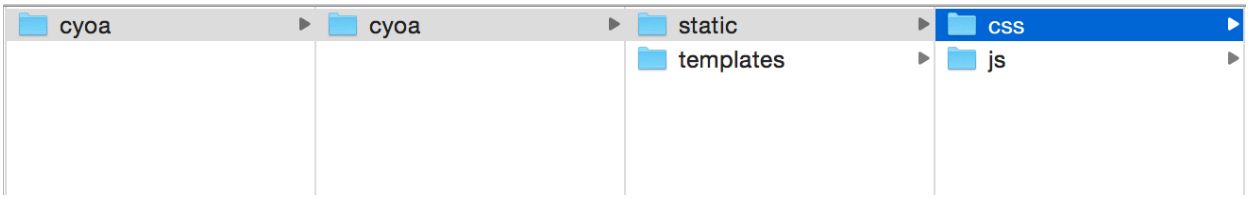
- Reveal.js for browser-based presentations
- Python with application dependencies:

    - Flask
    - Flask-SocketIO for handling websockets with Flask
    - Flask-Script for utility commands such as running our Flask server
    - Gunicorn to run our server
    - redis-py for interacting with Redis
- Redis for calculating results and short-term vote storage
- A Twilio account with an SMS number so audiences can vote which path the presentation should follow
- Ngrok for a secure tunnel to our local server running the presentation

Do you want to skip typing out the code yourself? Check out this open source repository on GitHub. The Git repository contains the final code as well as intermediate tags named tutorial-step-1, tutorial-step-2 and tutorial-step-3 for each section below.

Building the Presentation

First create the directory structure necessary for our project. The nested subdirectories will look like the following screenshot. Our base directory name and Flask app directory name will be `cyoa`, an acronym for "Choose Your Own Adventure."



At the base directory of our project, `cyoa/`, create a file named `requirements.txt` with the following content in it. Each line contains a dependency for our project that we'll install in a moment.

cyoa/requirements.txt

```
Flask==0.10.1
Flask-Script==2.0.5
Flask-SocketIO==0.4.1
gunicorn==19.1.1
redis==2.10.3
twilio==3.6.8
```

This application uses Flask to serve up the presentation. The Flask-Script extension will assist us in creating a `manage.py` file with helper commands to

run the web application. The Flask-SocketIO extension handles the server-side WebSockets communication.

Create a new virtualenv outside the base project directory to separate your Python dependencies from other apps you are working on.

```
virtualenv cyoa
```

Activate the virtualenv before we install the dependencies.

```
source cyoa/bin/activate
```

To install these dependencies run pip on the command line.

```
pip install -r requirements.txt
```

Create a file named `cyoa/manage.py` with the following contents.

cyoa/manage.py

```
from gevent import monkey
monkey.patch_all()

import os

from cyoa import app, redis_db, socketio
from flask.ext.script import Manager, Shell

manager = Manager(app)

def make_shell_context():
    return dict(app=app, redis_db=redis_db)

manager.add_command("shell", Shell(make_context=make_shell_context))

@manager.command
def runserver():
    socketio.run(app, "0.0.0.0", port=5001)

if __name__ == '__main__':
    manager.run()
```

The above `manage.py` file will help us run our Flask application with the `python manage.py runserver` command once we've put more of the pieces in places.

Next create a file `cyoa/cyoa/config.py` (the `cyoa/cyoa` subdirectory is where most of our Python code will live other than `manage.py`) and add the below code to create the configuration variables we'll need for our Flask application.

cyoa/cyoa/config.py

```
import os

# General Flask app settings
DEBUG = os.environ.get('DEBUG', None)
SECRET_KEY = os.environ.get('SECRET_KEY', None)

# Redis connection
REDIS_SERVER = os.environ.get('REDIS_SERVER', None)
REDIS_PORT = os.environ.get('REDIS_PORT', None)
REDIS_DB = os.environ.get('REDIS_DB', None)

# Twilio API credentials
TWILIO_ACCOUNT_SID = os.environ.get('TWILIO_ACCOUNT_SID', None)
TWILIO_AUTH_TOKEN = os.environ.get('TWILIO_AUTH_TOKEN', None)
TWILIO_NUMBER = os.environ.get('TWILIO_NUMBER', None)
```

Here is a run down of what each of these environment variables specified in `config.py` is for:

- `DEBUG` – True or False for whether Flask should display error messages if something goes wrong
- `SECRET_KEY` – a long key that should be kept secret
- `REDIS_SERVER` – in this case likely to be localhost or wherever Redis is running
- `REDIS_PORT` – generally set to 6379 for the default Redis port
- `REDIS_DB` – set to 0
- `TWILIO_ACCOUNT_SID` – found on your [Twilio account dashboard]
- `TWILIO_AUTH_TOKEN` – also found on your [Twilio account dashboard]
- `TWILIO_NUMBER` – a number you've [purchased on Twilio]

Set the `DEBUG` and `SECRET_KEY` environment variables now. The Redis and Twilio environment variables will be set in the next section.

Setting up environment variables depends on your operating system. There are guides for every major operating system, whether that is Ubuntu Linux, Mac OS X or Windows.

The next file we need to create is `cyoa/cyoa/__init__.py`, which will set up the core pieces for our the Flask app.

cyoa/cyoa/init.py

```
from flask import Flask
from flask.ext.socketio import SocketIO
import redis
```

```
app = Flask(__name__, static_url_path='/static')
app.config.from_pyfile('config.py')

from config import REDIS_SERVER, REDIS_PORT, REDIS_DB

redis_db = redis.StrictRedis(host=REDIS_SERVER, port=REDIS_PORT, db=REDIS_DB)

socketio = SocketIO(app)

from . import views
```

Next create a file named `cyoa/cyoa/views.py` that contains the following code.

cyoa/cyoa/views.py

```
from flask import render_template, abort
from jinja2 import TemplateNotFound

from . import app

@app.route('/<presentation_name>/', methods=['GET'])
def landing(presentation_name):
    try:
        return render_template(presentation_name + '.html')
    except TemplateNotFound:
        abort(404)
```

For now the above file contains a single view named `landing`. This view `landing` obtains a presentation name from the URL and checks the `cyoa/cyoa/templates/` directory for an HTML template file matching that name. If a matching file is found, `landing` renders the HTML template. If no file name matches the presentation name in the URL, `landing` returns a 404 HTTP response.

We are awfully close to getting to fire up this presentation to take a look at it. An HTML template file along with some static files are necessary for displaying the presentation. Create a Reveal.js presentation in templates directory named `cyoa/cyoa/templates/cyoa.html`. Add the following HTML inside this file.

cyoa/cyoa/templates/cyoa.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="utf-8">
    <title>Choose Your Own Adventure Presentations with Reveal.js!</title>
    <meta name="apple-mobile-web-app-capable" content="yes" />
    <meta name="apple-mobile-web-app-status-bar-style" content="black-translucent" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0, maximum-scale=1.0, user-s
```

```
calable=no, minimal-ui">
    <link rel="stylesheet" href="/static/css/reveal.css">
    <link rel="stylesheet" href="/static/css/default.css" id="theme">
    <link rel="stylesheet" href="/static/css/zenburn.css">
    <!--[if lt IE 9]>
    <script src="lib/js/html5shiv.js"></script>
    <![endif]-->
  </head>
  <body>
    <div class="reveal">
      <div class="slides">
        <section>
          <h1>Choose Your Own Adventure!</h1>
          <h3>With SMS voting</h3>
        </section>

        <section>
          <div>
            <h2>Text "left" or "right" to</h2>
            <!-- replace this with your Twilio number -->
            <h1>(xxx) 555-1234</h1>
          </div>
          <br>
          <div style="display: inline;">
            <div style="float: left;">
              <h2><a href="#/2">left</a></h2>
              <h1><div id="left">0</div> votes</h1>
            </div>
            <div style="float: right;">
              <h2><a href="#/3">right</a></h2>
              <h1><div id="right">0</div> votes</h1>
            </div>
          </div>
        </section>

        <!-- linked from first choice -->
        <section>
          <h1>Left</h1>
        </section>

        <!-- linked from second choice -->
        <section>
          <h1>Right</h1>
        </section>

      </div>
    </div>

    <script type="text/javascript"
            src="http://code.jquery.com/jquery-1.11.1.min.js"></script>
    <script type="text/javascript"
            src="//cdnjs.cloudflare.com/ajax/libs/socket.io/0.9.16/socket.io.min.js">
    </script>
    <script src="/static/js/reveal.js"></script>

    <script>
      Reveal.initialize({
        controls: true,
        progress: true,
        history: true,
        center: true,
        theme: Reveal.getQueryHash().theme,
        transition: Reveal.getQueryHash().transition || 'default',
        dependencies: []
```

```
      });
    </script>
  </body>
</html>
```

As you can see in the HTML there are three locally hosted static CSS files and a JavaScript file you'll need for your project. Download these files from GitHub or download and extract this `cyoa.tar.gz` archive into the `cyoa/cyoa/static` directory. The CSS and JavaScript files we need are the following: `js/reveal.js` – *code for creating the beautiful Reveal.js presentation* `css/default.css` – default style for Reveal.js decks `css/reveal.css` – *required for running Reveal.js presentations properly* `css/zenburn.css` – necessary for syntax highlighting within a presentation

With these files in place we can try out the presentation to make sure everything so far is in working order. Fire up Flask with the following command.

```
python manage.py runserver
```

Now we can view the initial version of the presentation by going to http://localhost:5001/cyoa/ in the browser. Flask will find the `cyoa.html` file in the `templates` directory and serve that up so you can view it.

However, the presentation will only come up on your own computer. To access the presentation from other computers you'll need to deploy to a hosting server or create a localhost tunnel using a tool such as Ngrok. Sign up for Ngrok and download the Ngrok tunneling application.

Fire up ngrok on port 5001 where our Flask application is running. See this configuring Ngrok post if you are running Windows. On Linux and Mac OS X Ngrok can be run with the following command when you're in the directory that ngrok is located in.

```
./ngrok 5001
```

You'll see a screen like the following. Take note of the unique `https://` forwarding URL as we'll need that again in a minute for the Twilio webhook.

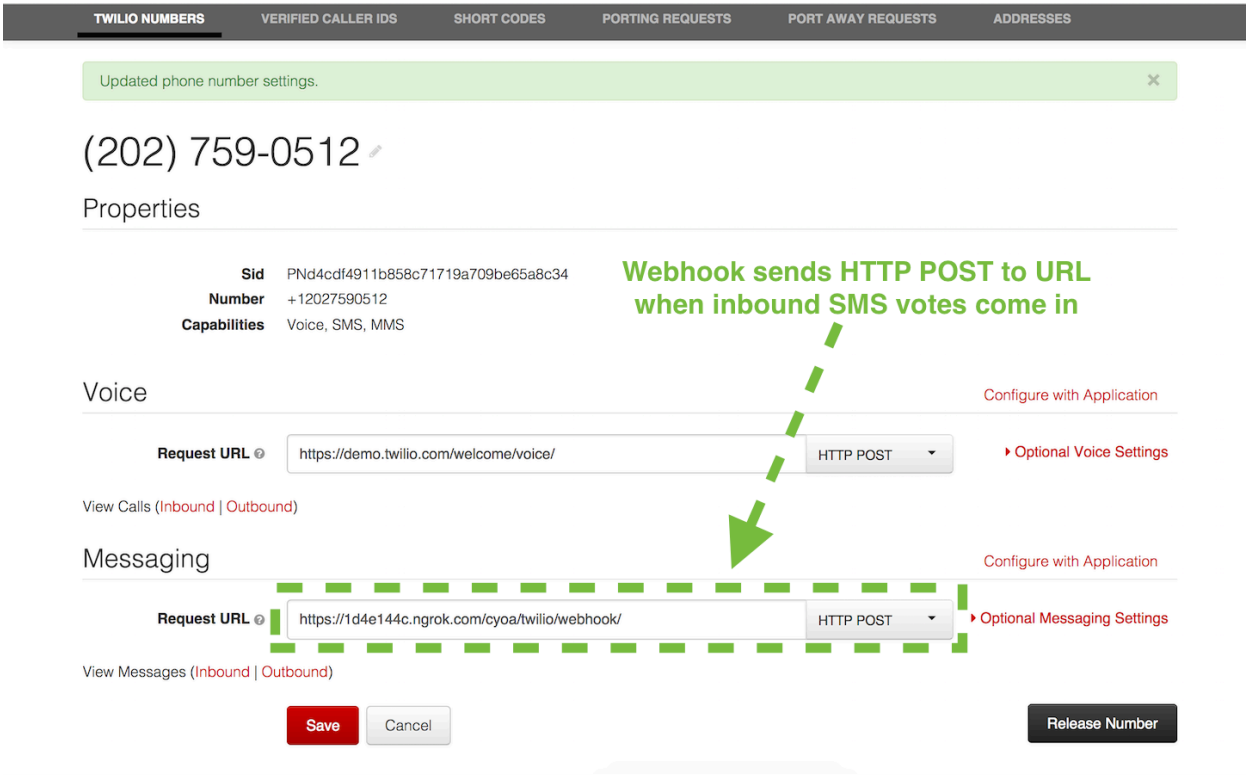
You can now pull the presentation both from the localhost URL as well as the forwarding URL set up by ngrok.

Accepting SMS votes

So far we wrote the Python code to serve a Reveal.js presentation and exposed it via a localhost tunnel. Now we need a way for the audience to vote on which path they want the presentation to go. To do that we'll show a Twilio phone number on the screen and use Twilio SMS to let the audience vote. If you've already got an account grab a new or existing phone number, otherwise sign up and upgrade a Twilio account.

We need to set up the message webhook so that each vote SMS to the Twilio number is sent to our Flask app. The Twilio number screen should look like

the following screenshot.



Paste in your Ngrok forwarding URL, which will look like `https://unique Ngrok code.ngrok.com`, along with `/cyoa/twilio/webhook/` to the Messaging Request URL text box then hit save. For example, if your Ngrok tunnel is "1d4e144c" your URL to paste into the webhook text box should look like the following URL.

```
https://1d4e144c.ngrok.com/cyoa/twilio/webhook/
```

Now Twilio will send a POST HTTP request to the ngrok port forwarding URL which will be sent down to your localhost server.

Make sure to update the phone number in your `cyoa/cyoa/templates/cyoa.html` presentation file. Look for the line like the following and replace it with your Twilio number.

cyoa/cyoa/templates/cyoa.html

```
<!- update your number here -->
(xxx) 555-1234
```

However, we are not yet ready to accept those incoming SMS votes. First we need to ensure Redis is running and write Python code to persist votes to it.

Ensure that the Redis server is installed on your system since that will be our temporary vote storage system. There's a quickstart installation guide available for your operating system of choice if you're unfamiliar with Redis. In that quickstart you just need to go from the beginning through the "Starting Redis" section and you'll be set for finishing this project.

Let's add code in our `cyoa/cyoa/views.py` file for the Twilio webhook HTTP POST that occurs on an inbound SMS. We'll increment a counter for each keyword texted in by people in the audience.

cyoa/cyoa/views.py

```
import cgi
from flask import render_template, abort, request
from jinja2 import TemplateNotFound
from twilio import twiml
from twilio.rest import TwilioRestClient
from .config import TWILIO_NUMBER
from . import app, redis_db

client = TwilioRestClient()

@app.route('/<presentation_name>/', methods=['GET'])
def landing(presentation_name):
    try:
        return render_template(presentation_name + '.html')
    except TemplateNotFound:
        abort(404)

@app.route('/cyoa/twilio/webhook/', methods='POST')
def twilio_callback():
    to = request.form.get('To', '')
    from_ = request.form.get('From', '')
    message = request.form.get('Body', '').lower()
    if to == TWILIO_NUMBER:
        redis_db.incr(cgi.escape(message))
    resp = twiml.Response()
    resp.message("Thanks for your vote!")
    return str(resp)
```

It'd be useful to have a way to clear out votes from Redis in between rehearsals for our presentation. Update `cyoa/manage.py` with a new function to clear votes from Redis.

cyoa/manage.py

```
from gevent import monkey
monkey.patch_all()

import os
import redis
from cyoa import app, redis_db, socketio
from flask.ext.script import Manager, Shell
```

```
manager = Manager(app)

def make_shell_context():
    return dict(app=app, redis_db=redis_db)

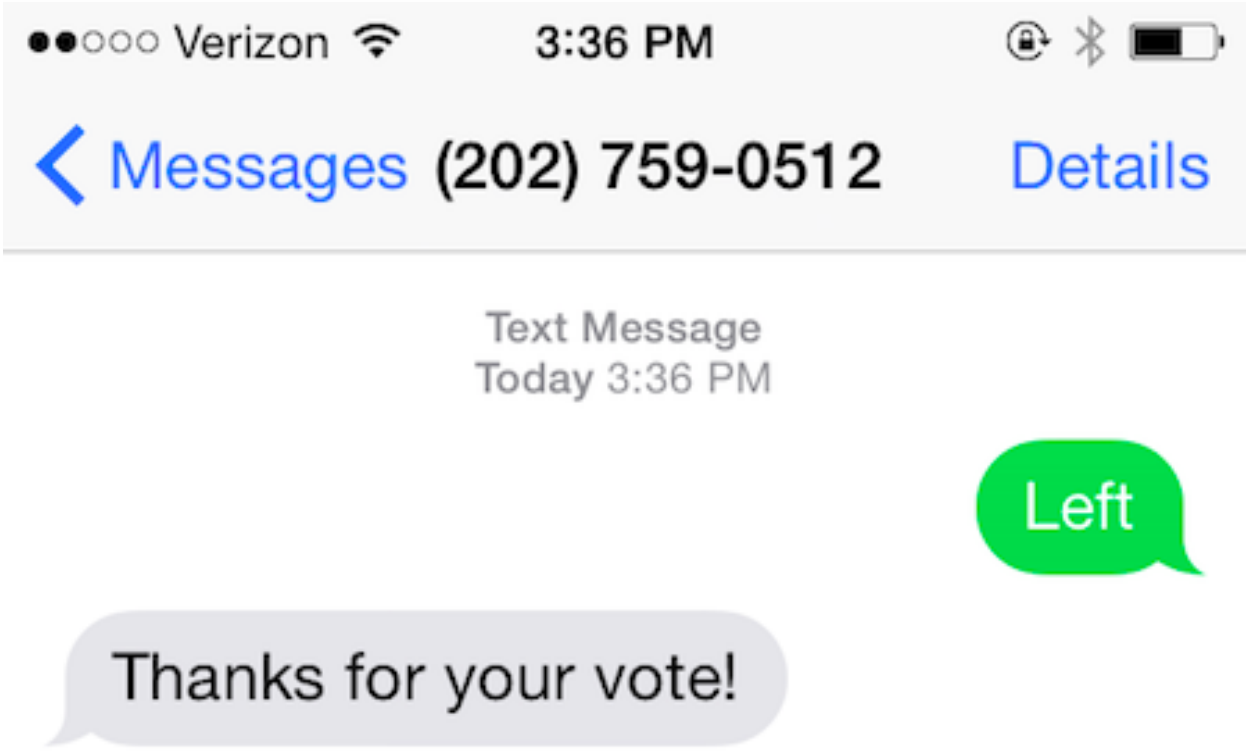
manager.add_command("shell", Shell(make_context=make_shell_context))

@manager.command
def runserver():
    socketio.run(app, "0.0.0.0", port=5001)

@manager.command
def clear_redis():
    redis_cli = redis.StrictRedis(host='localhost', port='6379', db='0')
    redis_cli.delete('left')
    redis_cli.delete('right')

if __name__ == '__main__':
    manager.run()
```

If Flask and ngrok are still running we can test this out now, otherwise fire them up and text either "left" or "right" to your Twilio number. When you test out SMS inbound text messages you should receive the "Thanks for your vote!" response like in the screenshot below.



At this point those inbound text message votes are also being stored in Redis. We're so close to wrapping up this code at this point let's write a bit more

Python to test that the messages are indeed in Redis and propagate the results to the presentation via websockets.

Adding WebSockets for Real-time Updates

We need one more new Python file to handle the server-side websockets communication. Websockets allow streams of communication between the client and server. In our presentation that allows the vote counts to be updated on the presentation slide as soon as the server emits a new message. Add a file named `cyoa/cyoa/websockets.py` with the following code to set up the server-side websockets implementation.

websockets.py

```
from flask.ext.socketio import emit

from . import socketio

@socketio.on('connect', namespace='/cyoa')
def test_connect():
    pass

@socketio.on('disconnect', namespace='/cyoa')
def test_disconnect():
    pass
```

The above code in the `update_count` function allows the websocket clients, in this case the browser that loads the presentation, to connect to the websockets stream and receive future messages.

Add one line to the bottom of `cyoa/cyoa/__init__.py` to import the `cyoa/cyoa/websockets.py` file we just wrote.

cyoa/cyoa/init.py

```
from flask import Flask
from flask.ext.socketio import SocketIO
import redis

app = Flask(__name__, static_url_path='/static')
app.config.from_pyfile('config.py')

from config import REDIS_SERVER, REDIS_PORT, REDIS_DB

redis_db = redis.StrictRedis(host=REDIS_SERVER, port=REDIS_PORT, db=REDIS_DB)

socketio = SocketIO(app)

from . import views
from . import websockets
```

Update `cyoa/cyoa/views.py` with the following highlighted lines. We are adding the `socketio.emit` call so votes are passed via websockets to the presentation.

cyoa/cyoa/views.py

```
import cgi
from flask import render_template, request, abort
from jinja2 import TemplateNotFound
from twilio import twiml
from twilio.rest import TwilioRestClient

from .config import TWILIO_NUMBER
from . import app, redis_db
from . import socketio

client = TwilioRestClient()

@app.route('/<presentation_name>/', methods=['GET'])
def landing(presentation_name):
    try:
        return render_template(presentation_name + '.html')
    except TemplateNotFound:
        abort(404)

@app.route('/cyoa/twilio/webhook/', methods=['POST'])
def twilio_callback():
    to = request.form.get('To', '')
    from_ = request.form.get('From', '')
    message = request.form.get('Body', '').lower()
    if to == TWILIO_NUMBER:
        redis_db.incr(cgi.escape(message))
         socketio.emit('msg', {'div': cgi.escape(message),
                               'val': redis_db.get(message)},
                       namespace='/cyoa')

    resp = twiml.Response()
    resp.message("Thanks for your vote!")
    return str(resp)
```

Add the highlighted code below to the `cyoa/cyoa/templates/cyoa.html` HTML presentation file. This code relies on the websockets JavaScript library and JQuery that was included with the file when we originally created it.

/cyoa/cyoa/templates/cyoa.html

```
<script type="text/javascript">
  Reveal.initialize({
    controls: true,
    progress: true,
    history: true,
    center: true,
    theme: Reveal.getQueryHash().theme,
    transition: Reveal.getQueryHash().transition || 'default',
    dependencies: [
    ]
  });
```

```
  $(document).ready(function() {
    namespace = '/cyoa';
    var socket = io.connect('http://' + document.domain + ':' + location.port + namespace);

    /* add and edit choices here */
    var appropriate_choices = ['left','right',];

    socket.on('msg', function(msg) {
      /* ensure valid vote and div exists */
      if (appropriate_choices.indexOf(msg.div) >= 0) {
        var checkDiv = $('#' + msg.div);
        if (checkDiv.length > 0) {
          checkDiv.html(msg.val);
        }
      }
    });
  });
</script>
```

Fire up Flask with Ngrok again. Check out http://localhost:5001/cyoa/ on your browser and you will see the same presentation as before. However, text your vote of 'left' or 'right' to your number and the votes will appear like in the screenshot below without any page refresh.

Wrapping it up

You now have a Flask app that can serve up Reveal.js presentations where the audience can interact with the slide on screen by texting in their votes. Now it's up to you to create the Choose Your Own Adventure content!

Choose Your Own Adventure Presentations: Wizard Mode Part 1 of 3

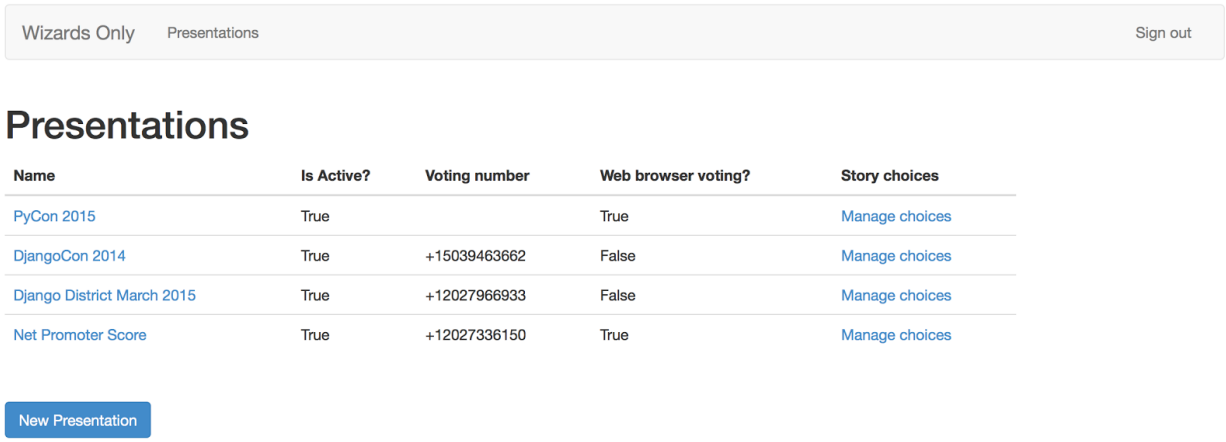
You've coded your way through the harrowing challenges of the first part of the Choose Your Own Adventure Presentations tutorial. A sign lies in the road ahead. "PyCon has summoned you to give a Choose Your Own Adventure talk in Montreal!", it reads.

———— How do you proceed? If you choose to run from the PyCon challenge, close the browser window now. If you accept the challenge, prepare yourself for the dangers ahead with the new Wizard Mode functionality and continuing reading this tutorial. ————

You are still here, adventurer! Let's get to work. In this series of three blog posts where we expand the Choose Your Own Adventure Presentations application with a new "Wizard Mode".

What is this mysterious Wizard Mode we are building? Think of it as an administrative interface that grants you, the presenting wizard, with new magical powers to control your presentations and how the audience can vote for story choices. The interface will only be accessible by authorized wizards through the sign-in page which will look like the following screenshot.

Once you're inside the application you'll be able to manage one or more Choose Your Own Adventure Presentations with a simple screen like this one:



As we go about building our new Wizard Mode you will learn about Flask form handling, WebSockets and how to persist presentation data to a PostgreSQL database.

There are three posts in this tutorial series where we will incrementally build out functionality:

1. **Wizards Only**: this blog post, where we create a section of the application only authorized wizards can access.
2. **Even Wizards Need Web Forms**: the next blog post where we expand the wizard only pages to control our presentations
3. **Voting with a Wand, or Smartphone**: our third and final post where we add a new magical trick to our presentations – voting via web browser when poor cell service prevents SMS voting

At the end of each post we'll be able to test what we just built to make sure it is working properly. If something goes wrong while you are working through the tutorial, the Git tag tutorial-step-4 tag has the end result for code written in this post.

Let's get to work!

Tools We Need

We will continue using open source code to build our project including the existing Choose Your Own Adventure Presentations code base, PostgreSQL and several additional Python libraries. Don't worry about downloading anything just yet – we will grab these tools throughout the tutorial. This list is just so you know ahead of time what will be installed along the way:

- CYOA Presentations repository at the tutorial-step-3 tag stage
- PostgreSQL for persistent storage
- The psycopg2 Python driver to connect to PostgreSQL
- Flask-login for authentication
- Flask-WTF for web form handling

Finally, time to roll up the magical cloak sleeves again and dive into coding.

Wizards Only

We'll create the wizard's panel to control multiple presentations and how our audience can interact with them. First though we need a way to sort wizards from non-wizards in the form of a sign-in screen.

Our project will use four new Python code libraries so let's get those added to our project. These new libraries are highlighted below. Update the `requirements.txt` file so it matches the following code.

```
Flask==0.10.1
Flask-Script==2.0.5
Flask-SocketIO==0.4.1
Flask-Login==0.2.11
Flask-SQLAlchemy==2.0
Flask-WTF==0.10.3
gunicorn==19.1.1
redis==2.10.3
twilio==3.6.8
psycopg2==2.5.4
```

Make sure to active your project's virtualenv and install the new dependencies with pip using these two steps:

```
source ~/Envs/cyoa/bin/activate
pip install -r requirements.txt
```

With our new dependencies in place we can create our Wizards Only sign-in page.

Create a new file named `models.py` within the `cyoa/cyoa/` subdirectory to store information about wizards. The file should have the following contents:

cyoa/cyoa/models.py

```
from flask.ext.login import UserMixin
from werkzeug.security import generate_password_hash, check_password_hash

from . import db


class Wizard(UserMixin, db.Model):
    """
        Represents a wizard who can access special parts of the application.
    """
    __tablename__ = 'wizards'
    id = db.Column(db.Integer, primary_key=True)
    wizard_name = db.Column(db.String(64), unique=True, index=True)
    password_hash = db.Column(db.String(128))


    def __init__(self, wizard_name, password):
        self.wizard_name = wizard_name
        self.password = password


    @property
    def password(self):
        raise AttributeError('password is not readable')
```

```
    @password.setter
    def password(self, password):
        self.password_hash = generate_password_hash(password)


    def verify_password(self, password):
        return check_password_hash(self.password_hash, password)


    def __repr__(self):
        return '' % self.wizard_name
```

Next we need to modify the `cyoa/cyoa/__init__.py` file to create a login manager. The login manager will allow us to control access to wizard settings.

cyoa/cyoa/init.py

```
import redis
from flask import Flask
from flask.ext.login import LoginManager
from flask.ext.sqlalchemy import SQLAlchemy
from flask.ext.socketio import SocketIO
from config import REDIS_SERVER, REDIS_PORT, REDIS_DB


app = Flask(__name__, static_url_path='/static')
app.config.from_pyfile('config.py')

redis_db = redis.StrictRedis(host=REDIS_SERVER, port=REDIS_PORT, db=REDIS_DB)

socketio = SocketIO(app)
db = SQLAlchemy(app)

login_manager = LoginManager()
login_manager.login_view = 'sign_in'
login_manager.init_app(app)

from . import views
from . import websockets
```

We need to configure where the database is located in a configuration parameter so our SQLAlchemy database loads properly. Make sure you have PostgreSQL installed on your system. Here are some handy guides and downloads to install PostgreSQL on Ubuntu Linux, Windows and Mac OS X.

Our new configuration variable will reside in our `config.py` file as highlighted below.

```
import os


# General Flask app settings
DEBUG = os.environ.get('DEBUG', None)
SECRET_KEY = os.environ.get('SECRET_KEY', None)
SQLALCHEMY_DATABASE_URI = os.environ.get('DATABASE_URL', None)
```

```
# Redis connection
REDIS_SERVER = os.environ.get('REDIS_SERVER', None)
REDIS_PORT = os.environ.get('REDIS_PORT', None)
REDIS_DB = os.environ.get('REDIS_DB', None)

# Twilio API credentials
TWILIO_ACCOUNT_SID = os.environ.get('TWILIO_ACCOUNT_SID', None)
TWILIO_AUTH_TOKEN = os.environ.get('TWILIO_AUTH_TOKEN', None)
TWILIO_NUMBER = os.environ.get('TWILIO_NUMBER', None)
```

In our original Choose Your Own Adventure Presentations blog post we set the other environment variables listed in the above `config.py` file. Set an environment variable for `DATABASE_URL` that will be loaded into `SQLALCHEMY_DATABASE_URI`. The value for this variable will be a URI that points to your running PostgreSQL database. For example, in my local development environment the `DATABASE_URL` is set to `postgresql://matt:password123@localhost/cyoa`. And no, that's not the actual password value I use on my development environment.

We need a form to handle data coming from a wizard. In our application the Flask-WTF library is going to handle form generation and input sanitization. Create a new file named `forms.py` in your `cyoa/` subdirectory.

```
from flask.ext.wtf import Form
from wtforms import StringField, PasswordField, BooleanField, SubmitField, \
                    DateField, IntegerField
from wtforms.validators import Required, Length, Regexp, EqualTo
from wtforms import ValidationError
from .models import Wizard


class LoginForm(Form):
    wizard_name = StringField('Wizard Name',
                              validators=[Required(), Length(1, 32)])
    password = PasswordField('Password', validators=[Required(),
                                                     Length(1, 32)])

    def validate(self):
        if not Form.validate(self):
            return False
        user = Wizard.query.filter_by(wizard_name=self.
                                      wizard_name.data).first()
        if user is not None and not user.verify_password(self.password.data):
            self.password.errors.append('Incorrect password.')
            return False
        return True
```

The above code creates a Python representation of the sign-in page form. We add a custom validator within the validate function to ensure the password entered by the user matches what's stored in the database. If the form input

passes the validation function then True is returned and the form processing continues along in our `views.py` file.

Now in `cyoa/cyoa/views.py` we need a couple of functions to handle signing wizards in and out of their special part of the application.

```
import cgi
from flask import render_template, abort, request
from flask import redirect, url_for
from flask.ext.login import login_user, logout_user, login_required, \
                            current_user
from jinja2 import TemplateNotFound
from twilio import twiml
from twilio.rest import TwilioRestClient

from .config import TWILIO_NUMBER
from .forms import LoginForm
from .models import Wizard

from . import app, redis_db, socketio
from . import login_manager


client = TwilioRestClient()

@login_manager.user_loader
def load_user(userid):
    return Wizard.query.get(int(userid))

@app.route('/<presentation_name>/', methods=['GET'])
def landing(presentation_name):
    try:
        return render_template(presentation_name + '.html')
    except TemplateNotFound:
        abort(404)

@app.route('/cyoa/twilio/webhook/', methods=['POST'])
def twilio_callback():
    to = request.form.get('To', '')
    from_ = request.form.get('From', '')
    message = request.form.get('Body', '').lower()
    if to == TWILIO_NUMBER:
        redis_db.incr(cgi.escape(message))
        socketio.emit('msg', {'div': cgi.escape(message),
                              'val': redis_db.get(message)},
                      namespace='/cyoa')
    resp = twiml.Response()
    resp.message("Thanks for your vote!")
    return str(resp)

@app.route('/wizard/', methods=['GET', 'POST'])
def sign_in():
    form = LoginForm()
    if form.validate_on_submit():
        wizard = Wizard.query.filter_by(wizard_name=
                                        form.wizard_name.data).first()
        if wizard is not None and wizard.verify_password(form.password.data):
            login_user(wizard)
            return redirect(url_for('wizard_landing'))
    return render_template('wizard/sign_in.html', form=form, no_nav=True)

@app.route('/sign-out/')
```

```
@login_required
def sign_out():
    logout_user()
    return redirect(url_for('sign_in'))

@app.route('/wizard/presentations/')
@login_required
def wizard_landing():
    return render_template('wizard/presentations.html')
```

In the code above we include the new login manager we created in the `cyoa/cyoa/__init__.py` file. We then implement a login manager callback function named `load_user` which reloads a `Wizard` object from the user ID stored in the session. There are three additional functions:

- `sign_in`: authenticate a user as a valid wizard to get into the app
- `sign_out`: deauthenticate a logged in wizard's session
- `wizard_landing`: a simple stub page only accessible to wizards to prove the authentication is working properly

We have the code to run the app but there are no templates to render yet. Create the required templates now so we can test our application. Under the `cyoa/cyoa/templates/` folder create a new file named `base.html` with the following template code:

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="utf-8">
    <meta http-equiv="X-UA-Compatible" content="IE=edge">
    <meta name="viewport" content="width=device-width, initial-scale=1">
    <meta name="description" content="">
    <meta name="author" content="Matt Makai">
    <title>{% block title %}{% endblock %}CYOA Presentations</title>
    <link rel="stylesheet" href="https://maxcdn.bootstrapcdn.com/bootstrap/3.2.0/css/bootstrap.mi
n.css">
    <link rel="stylesheet" href="/static/css/wizard.css">
    {% block css_head %}{% endblock %}
    <!--[if lt IE 9]>
      <script src="https://oss.maxcdn.com/html5shiv/3.7.2/html5shiv.min.js">
      </script>
      <script src="https://oss.maxcdn.com/respond/1.4.2/respond.min.js">
      </script>
    <![endif]-->
  </head>
  <body{% block body_class %}{% endblock %}>
    {% block nav %}{% endblock %}
    {% block content %}{% endblock %}
    {% block js_body %}{% endblock %}
  </body>
</html>
```

The above template serves as a base HTML template file that other templates can extend. Our sign-in page and our wizard landing page will both extend `base.html`.

You may notice we have a new `wizard.css` file included in our `base.html` file. There are a few extra styles and a background image we will include in our app. Rather than having you type out all that code you'll want to download the file cyoa-tutorial-step-4.tar.gz and extract it under the `cyoa/cyoa/static/` directory so those files can be served up when we run our application.

`base.html` eliminates the boilerplate code we don't want to write in every template, but we can go even further with our Don't Repeat Yourself (DRY) principle by using a helper to render forms. Make a subdirectory named partials under the `cyoa/cyoa/templates/` directory. Within partials construct a file named `_formhelpers.html` and put the following template code inside:

```
{% macro render_field(field) %}
  <dt style="text-align: left;" class="admin-field">{{ field.label }}
  {% if field.errors %}
    <ul class="errors">
      {% for error in field.errors %}
        <li style="color: red;">{{ error }}</li>
      {% endfor %}
    </ul>
  {% endif %}
  <dd>{{ field(class_="form-control", **kwargs)|safe }}
  </dd>
{% endmacro %}
```

Every time we render a form field in future templates we can include the above file and it will insert the boilerplate code for a single field into the template.

Next, create a new directory in your project named `cyoa/cyoa/templates/wizard/`. Within the `cyoa/cyoa/templates/wizard/` directory create a new file named `sign_in.html` with the following template:

```
{% extends "base.html" %}

{% block css_head %}
    <link href="/static/css/signin.css" rel="stylesheet">
{% endblock %}

{% block body_class %} class="wizard-bg" {% endblock %}
```

```
{% block content %}
<div class="container sign-in">
  <div class="col-md-12">
    <div id="login">
      <h1>Wizards Only!</h1>
      {% from "partials/_formhelpers.html" import render_field %}
      <form method="post" action="{{ url_for('sign_in') }}"
            id="login-form">
        {{ form.csrf_token }}
        {{ render_field(form.wizard_name, required=True) }}
        <br>
        {{ render_field(form.password, required=True) }}
        <div style="margin-top: 10px; text-align: right;">
          <input class="btn btn-primary"
                 type="submit" value="Sign in" />
        </div>
      </form>
    </div>
  </div>
</div>
<footer class="footer">
  <div class="container">
    <p class="text-muted pull-right">
      Photo by <a href="http://photos.jdhancock.com/photo/2012-04-16-000233-a-spot-of-magic.html">J
D Hancock</a>
    </p>
  </div>
</footer>
{% endblock %}
```

The template renders a page with a nice wizard background image for some extra flavor. We're close to running our app, but we need a page to render once the wizard gets past the sign-in page.

Create a new file named `cyoa/cyoa/templateswizard/presentations.html` that will store a stub page that we'll expand upon in part 2 of this tutorial.

```
{% extends "base.html" %}

{% block content %}
<div class="container">
  <div class="row">
    <div class="col-md-10">
      <h1>Wizards Only Stuff Here</h1>
      <a href="{{ url_for('sign_out') }}">Sign out</a>
    </div>
  </div>
</div>
{% endblock %}
```

With our application code and templates in place we just have one more file to update so we can run the application. Change the existing `manage.py` file with the following highlighted lines.

```
from gevent import monkey
monkey.patch_all()

import os
import redis

from cyoa import app, redis_db, socketio
from cyoa import db
from cyoa.models import Wizard
from flask.ext.script import Manager, Shell


manager = Manager(app)

def make_shell_context():
    return dict(app=app, redis_db=redis_db, db=db, Wizard=Wizard)

manager.add_command("shell", Shell(make_context=make_shell_context))

@manager.command
def syncdb():
    db.create_all()

@manager.command
def runserver():
    socketio.run(app, "0.0.0.0", port=5001)

@manager.command
def clear_redis():
    redis_cli = redis.StrictRedis(host='localhost', port='6379', db='0')
    redis_cli.delete('left')
    redis_cli.delete('right')

if __name__ == '__main__':
    manager.run()
```

We are itching to get this application running but we need to make sure our database is created along with our `Wizard` table. On the command line create PostgreSQL database using this command:

```
createdb cyoa
```

With our updated `manage.py` script we can create the database tables necessary for storing wizard data.

```
python manage.py syncdb
```

Also we need to populate our first authorized wizard. Start up the shell and enter the following code to create and save a wizard. You can modify the credentials as you see fit.

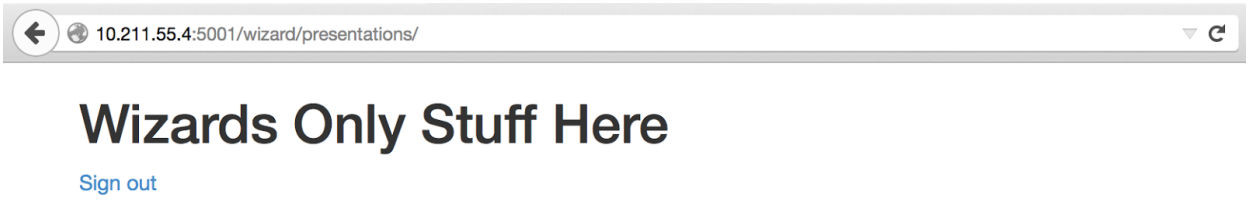
```
python manage.py shell
>>> db.session.add(Wizard('gandalf', 'thegrey'))
>>> db.session.commit()
>>> exit()
```

Finally, time to test out our new wizard sign-in screen! Within the base directory of our application run the built-in server using the following command:

```
python manage.py runserver
```

Head to http://localhost:5001/wizard/ in a web browser to bring up our application. Now we can authenticate as a wizard with the name and password we just added to the database.

After entering our credentials and hitting the Sign in button we'll see the following landing page.



Click the Sign out button to test out the `sign_out` function and ensure that we eliminate any trace of our wizard-ness to the application.

Wizards Only Engaged

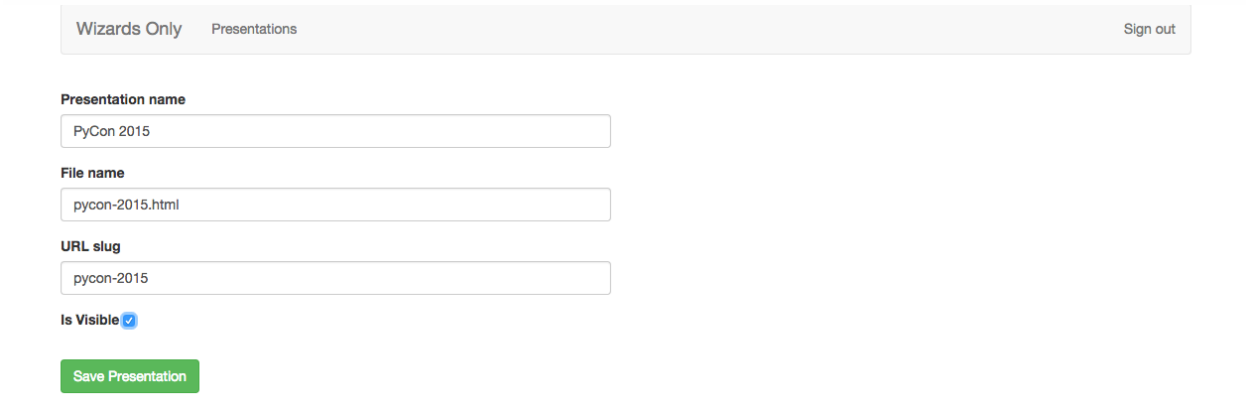
Our Wizards Only sign-in page is complete, but there is more work to be done. In part two of the Wizard Mode tutorial, we'll enable better control over presentations by building out our wizard pages.

Choose Your Own Adventure Presentations: Wizard Mode Part 2 of 3

In the first part of our Choose Your Own Adventure Presentations Wizard Mode tutorial we set up the necessary code for separating authorized wizards from non-wizards. However, logging in and out of an application isn't very magical. It's time to write write some new spells in Wizards Only mode to allow us to deftly manipulate our presentations.

Even Wizards Need Web Forms

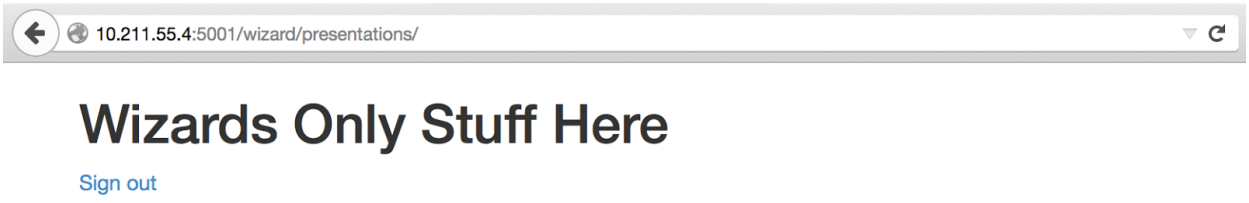
The Wizards Only mode interface we're creating throughout this post will grant us the ability to see which presentations are available as well as create and edit metadata, such as whether a presentation is visible or invisible to non-wizards.



Note that if you make a typo somewhere along the way in this section, you can compare your version with the tutorial-step-5 tag. Time to get coding and create our Wizards Only mode.

A New Wizards' Landing Page

The landing page we created in part 1 is just a stub that's not worthy of wizards who access our application.



To make the Wizards Only mode functional we'll build a new landing page that lists every presentation we've created through this user interface. Start by opening `cyoa/cyoa/views.py` and delete the placeholder `wizard_landing` function.

```
@app.route('/wizard/presentations/')
@login_required
def wizard_landing():
    return render_template('wizard/presentations.html')
```

Next, replace what we just deleted in `cyoa/cyoa/views.py` by creating a new file named `cyoa/cyoa/wizard_views.py` and populating it with the following code.

```
from flask import render_template, redirect, url_for
from flask.ext.login import login_required

from . import app, db

@app.route('/wizard/presentations/')
@login_required
def wizard_list_presentations():
    presentations = []
    return render_template('wizard/presentations.html',
                           presentations=presentations)

@app.route('/wizard/presentation/', methods=['GET', 'POST'])
@login_required
def wizard_new_presentation():
    pass

@app.route('/wizard/presentation/<int:id>/', methods=['GET', 'POST'])
@login_required
def wizard_edit_presentation(id):
    pass

@app.route('/wizard/presentation/<int:pres_id>/decisions/')
@login_required
def wizard_list_presentation_decisions(pres_id):
    pass

@app.route('/wizard/presentation/<int:pres_id>/decision/',
           methods=['GET', 'POST'])
@login_required
def wizard_new_decision(pres_id):
    pass

@app.route('/wizard/presentation/<int:presentation_id>/decision/'
           '<int:decision_id>/', methods=['GET', 'POST'])
@login_required
def wizard_edit_decision(presentation_id, decision_id):
 pass

@app.route('/wizard/presentation/<int:pres_id>/decision/'
           '<int:decision_id>/delete/')
@login_required
def wizard_delete_decision(pres_id, decision_id):
    pass
```

With the exception of the `wizard_list_presentations` function, every function above with the pass keyword in its body is just a stub for now. We'll flesh out those functions with code throughout the remainder of this post and also later in part 3 of the tutorial. For now we need them stubbed because otherwise the `url_for` function in our redirects and templates will not be able to look up the appropriate URL paths.

Go back to the `cyoa/cyoa/views.py` file. Edit the return redirect line shown below so it calls the new `wizard_list_presentations` function instead of `wizard_landing`.

```
@app.route('/wizard/', methods=['GET', 'POST'])
def sign_in():
    form = LoginForm()
    if form.validate_on_submit():
        wizard = Wizard.query.filter_by(wizard_name=
                                        form.wizard_name.data).first()
        if wizard is not None and wizard.verify_password(form.password.data):
            login_user(wizard)
            return redirect(url_for('wizard_list_presentations'))
    return render_template('wizard/sign_in.html', form=form, no_nav=True)
```

Our Flask application needs to access the new `wizard_views.py` functions. Add this single line to the end of the `cyoa/cyoa/__init__.py` file to make that happen:

```
from . import wizard_views
```

The templates for our new landing page don't exist yet, so let's create them now. Create a new file `cyoa/cyoa/templates/nav.html` and insert the HTML template markup below.

```
<div class="container">
  <div class="navbar navbar-default" role="navigation">
    <div class="container-fluid">
      <div class="navbar-header">
        <a class="navbar-brand" href="{{ url_for('wizard_list_presentations') }}">Wizards Only</a>
      </div>
      <div>
        <ul class="nav navbar-nav">
          <li><a href="{{ url_for('wizard_list_presentations') }}">Presentations</a></li>
        </ul>
        <ul class="nav navbar-nav navbar-right">
          <li><a href="{{ url_for('sign_out') }}">Sign out</a></li>
        </ul>
      </div>
    </div>
  </div>
</div>
```

The above template file is a navigation bar that will be included on logged in Wizard Only pages. You'll see the template tag `{% include "nav.html" %}` in every template that needs to display the navigation bar at the top of the webpage.

Next up we need to modify the temporary markup in the landing page template file so it displays the presentations we will create through the

Wizards Only user interface. Replace the temporary code found in `cyoa/cyoa/templates/wizard/presentations.html` with the following Jinja template markup.

```
{% extends "base.html" %}
{% block nav %}
  {% include "nav.html" %}
{% endblock %}

{% block content %}
<div class="container">
  <div class="row">
    <div class="col-md-10">
      <h1>Presentations</h1>
      {% if not presentations %}
        No presentations found.
        <a href="{{ url_for('wizard_new_presentation') }}">Create your first one</a>.
      {% else %}
        <table class="table">
          <thead>
            <tr>
              <th>Name</th>
              <th>Is Visible?</th>
              <th>Web browser voting?</th>
            </tr>
          </thead>
          <tbody>
            {% for p in presentations %}
              <tr>
                <td><a href="{{ url_for('wizard_edit_presentation', id=p.id) }}">{{ p.name
}}</a></td>
                <td>{{ p.is_visible }}</td>
                <td><a href="{{ url_for('wizard_list_presentation_decisions', pres_id=p.id) }}">Man
age choices</a></td>
              </tr>
            {% endfor %}
          </tbody>
        </table>
      {% endif %}
      </div>
    </div>
    <div class="row">
      <div class="col-md-10">
        <div class="btn-top-margin">
          <a href="{{ url_for('wizard_new_presentation') }}"
             class="btn btn-primary">New Presentation</a>
        </div>
      </div>
    </div>
  </div>
</div>
{% endblock %}
```

In the above markup we check the presentations object passed into the
template to determine if one or more presentations exist. If not, Flask
renders the template with a "No presentations found." message and a link
to create the first presentation. If one or more presentation objects do
exist, a table is rendered with the name of the presentation, whether it's
visible to non-wizard users and whether or not we've enabled web browser
voting (which we will code in part 3).

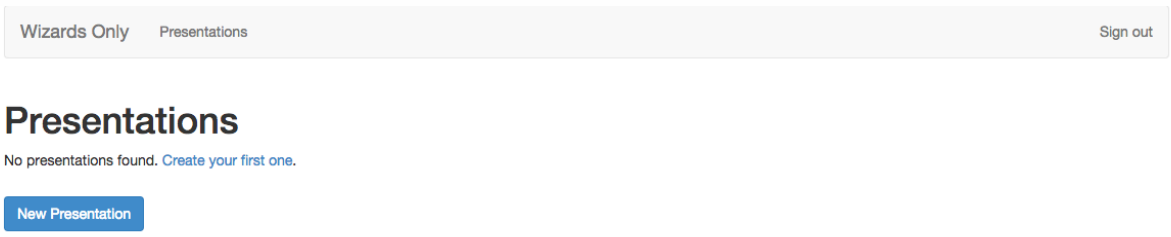
```
Time to test out the current state of our application to make sure it's
working properly. Make sure your virtualenv is activated and environment
variables are set as we established in part 1 of the tutorial. From the
base directory of our project, start the dev server with the
`python manage.py runserver` command.

```bash
(cyoa)$ python manage.py runserver
 * Running on http://0.0.0.0:5001/
 * Restarting with stat
```

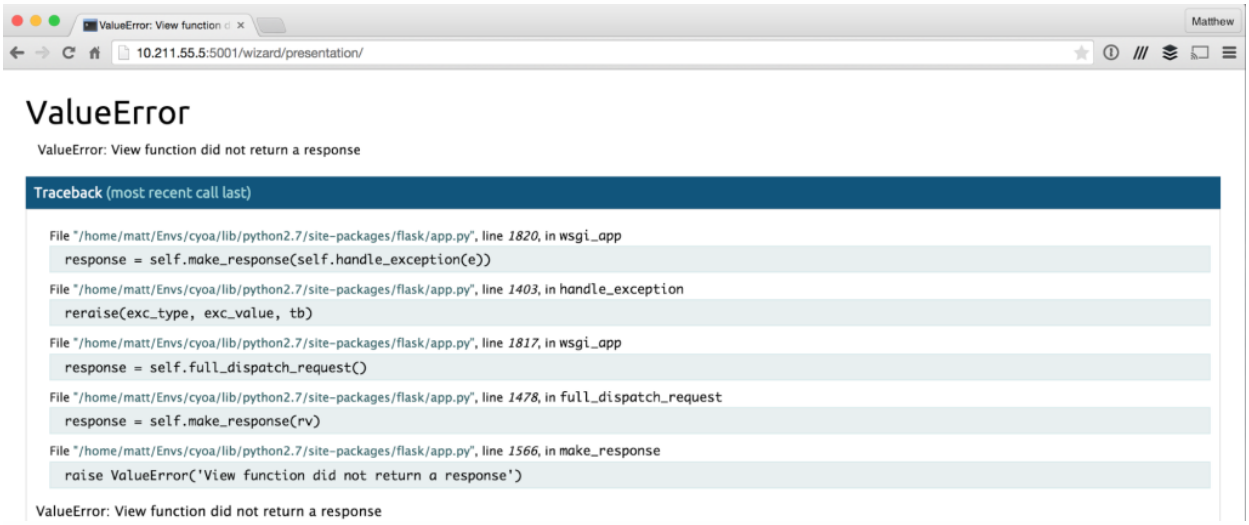
If your development server does not start up properly, make sure you've executed `pip install -r requirements.txt` to have all the dependencies the server requires. Occasionally there are issues installing the required gevent library the first time the dependencies are obtained via `pip`.

Open http://localhost:5001/wizard/ in your web browser. You should see the unchanged Wizards Only sign in page. Log in with your existing Wizard credentials created in part 1. The suggested credentials for part 1 were "gandalf" for the wizard name and "thegrey" for the password.

When you get into the application, the `presentations.html` template combined with our existing `base.html` and new `nav.html` will create a landing screen that looks like this:



However, we haven't written any code to power the "Create your first one" link and "New Presentation" buttons yet. If we click on the "New Presentation" button, we'll get a `ValueError` like we see in the screenshot below because that view does not return a response.
```



We will handle creating and editing presentations next.

Creating and Modifying Presentation Metadata

We built a page to display all presentations to logged in Wizards, but there is currently no way to add or edit presentation metadata. Why are we using the term "metadata" instead of just saying "presentations"? This Wizards Only user interface is only used to create and edit the presentations' information in the application, not the presentation files themselves. In other words, we're modifying the presentation metadata, not the HTML markup within the presentations. As we'll see later in the post, our application will use the metadata to look in the `cyoa/cyoa/templates/presentations` folder for a filename associated with a visible presentation.

Open up `cyoa/cyoa/models.py` and append the following code at the end of the file.

```
class Presentation(db.Model):
    """
        Contains data regarding a single presentation.
    """
    __tablename__ = 'presentations'
    id = db.Column(db.Integer, primary_key=True)
    name = db.Column(db.String(64), unique=True)
    slug = db.Column(db.String(128), unique=True)
    filename = db.Column(db.String(256))
    is_visible = db.Column(db.Boolean, default=False)

    def __repr__(self):
        return '<Presentation %r>' % self.name
```

The above Presentation class is a SQLAlchemy database model. Just like with our `Wizard` model, this model maps a Python object to the database table

`presentations` and allows our application to create, read, update and delete rows in the database for that table.

We also need a new form to handle the creating and editing of presentation metadata. We'll store this form in the `cyoa/cyoa/forms.py` file.

```
class PresentationForm(Form):
    name = StringField('Presentation name', validators=[Required(),
                                                        Length(1, 60)])
    filename = StringField('File name', validators=[Required(),
                                                    Length(1, 255)])
    slug = StringField('URL slug', validators=[Required(),
                                               Length(1, 255)])
    is_visible = BooleanField()
```

Now we need to tie together our new `Presentation` database model and `PresentationForm` form. In the `cyoa/cyoa/wizard_views.py`, remove the pass keyword from the listed functions and replace it with the highlighted code. What we're adding below are two imports for the `Presentation` and `PresentationFrom` classes we just wrote. Now that we have presentations in the database, we can query for existing presentations in the `wizard_list_presentations` function. In the `wizard_new_presentation` and `wizard_edit_presentation` functions, we use the `PresentationForm` class to create and modify `Presentation` objects through the application's web forms.

```
from . import app, db
from .models import Presentation
from .forms import PresentationForm

@app.route('/wizard/presentations/')
@login_required
def wizard_list_presentations():
    presentations = Presentation.query.all()
    return render_template('wizard/presentations.html',
                           presentations=presentations)

@app.route('/wizard/presentation/', methods=['GET', 'POST'])
@login_required
def wizard_new_presentation():
    form = PresentationForm()
    if form.validate_on_submit():
        presentation = Presentation()
        form.populate_obj(presentation)
        db.session.add(presentation)
        db.session.commit()
        return redirect(url_for('wizard_list_presentations'))
    return render_template('wizard/presentation.html', form=form, is_new=True)

@app.route('/wizard/presentation/<int:id>/', methods=['GET', 'POST'])
@login_required
def wizard_edit_presentation(id):
    presentation = Presentation.query.get_or_404(id)
```

```
    form = PresentationForm(obj=presentation)
    if form.validate_on_submit():
        form.populate_obj(presentation)
        db.session.merge(presentation)
        db.session.commit()
        db.session.refresh(presentation)
    return render_template('wizard/presentation.html', form=form,
                           presentation=presentation)
```

In the above code, make sure you've changed the first line within the `wizard_list_presentations` function from `presentations = []` to `presentations = Presentation.query.all()`. That modification to the code allows us to pass in every presentation found in the database into the `render_template` function instead of an empty list.

Create a new file named `cyoa/cyoa/templates/wizard/presentation.html`. There is already a `presentations.html` file with an 's' at the end, but this filename will render a singular presentation. Add the following HTML template within the new file:

```
{% extends "base.html" %}

{% block nav %}
  {% include "nav.html" %}
{% endblock %}

{% block content %}
<div class="container">
  <div class="row">
    <div class="col-md-6">
      {% from "partials/_formhelpers.html" import render_field %}
      {% if is_new %}
      <form action="{{ url_for('wizard_new_presentation') }}"
            method="post">
      {% else %}
      <form action="{{ url_for('wizard_edit_presentation', id=presentation.id) }}" method="post">
      {% endif %}
        <div>
          {{ form.csrf_token }}
          {{ render_field(form.name) }}
          {{ render_field(form.filename) }}
          {{ render_field(form.slug) }}
          <dt class="admin-field">
            {{ form.is_visible.label }}
            {{ form.is_visible }}
          </dt>
        </div>
        <div>
          <input type="submit" class="btn btn-success btn-top-margin"
                 value="Save Presentation"></input>
        </div>
      </form>
    </div>
  </div>
```

```
</div>
{% endblock %}
```

Let's give our upgraded code another spin. First, since we created a new database table we need to sync our `models.py` code with the database tables. Run the following `manage.py command at the command line from within the project's base directory.

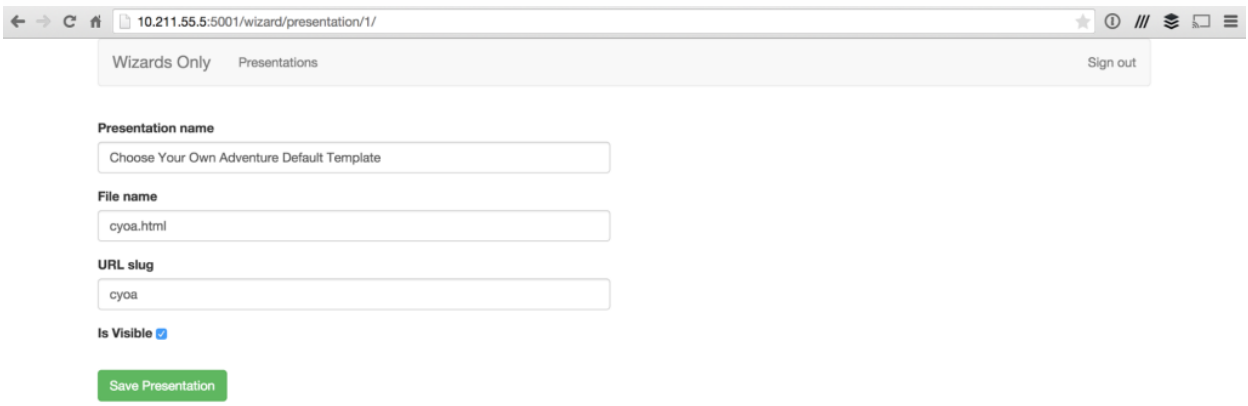
```
(cyoa)$ python manage.py syncdb
```

Now the tables in PostgreSQL match our updated `models.py` code. Bring up the application with the `runserver` command.

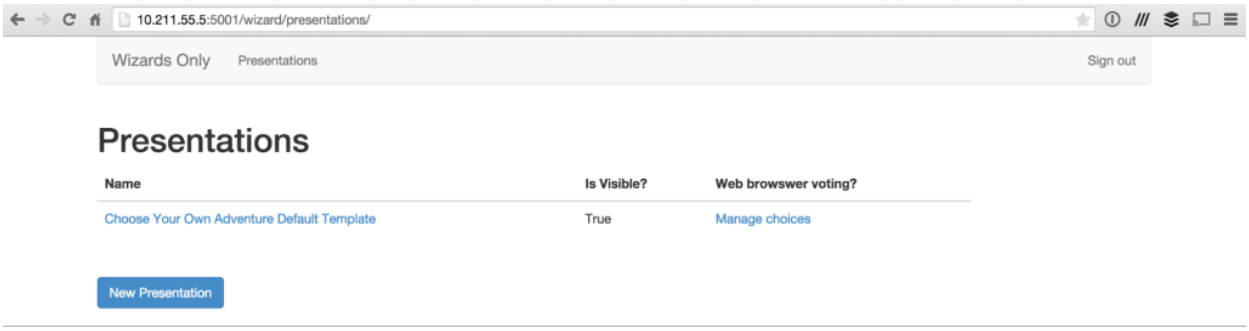
```
(cyoa)$ python manage.py runserver
```

Point your web browser to http://localhost:5001/wizard/. You should again see the unchanged Wizards Only sign in page.

Use your wizard credentials to sign in. At the presentations landing screen after signing in, click the "New Presentation" button.



Create a presentation for the default template that's included with the project. Enter "Choose Your Own Adventure Default Template" as the presentation name, "cyoa.html" for the file name, "cyoa" for the URL slug and check the "Is Visible" box. Press the "Save Presentation" button and we'll be taken back to the presentations list screen where our new presentation is listed.



We can edit existing presentations by clicking on the links within the Name column. Now we'll use this presentation information to display visible presentations to users not logged into the application.

Listing Available Presentations

There have been a slew of code changes in this blog post, but let's get one more in before we wrap up that'll be useful to presentation viewers. We're going to create a page that lists all presentations that are visible to non-wizard users so you can send out a URL to anyone that wants to bring up the slides on their own.

In addition, our presentation retrieval function will look for presentation files only in the `cyoa/cyoa/templates/presentations/` folder. The presentations can still be accessed from the same URL as before, but it's

easier to remember where presentation files are located when there's a single folder for them.

Start by deleting the following code in `cyoa/cyoa/views.py` as we will not need it any longer.

```
@app.route('/<presentation_name>/', methods=['GET'])
def landing(presentation_name):
    try:
        return render_template(presentation_name + '.html')
    except TemplateNotFound:
        abort(404)
```

In its place, insert the following code.

```
@app.route('/', methods=['GET'])
def list_public_presentations():
    presentations = Presentation.query.filter_by(is_visible=True)
    return render_template('list_presentations.html',
                           presentations=presentations)

@app.route('/<slug>/', methods=['GET'])
def presentation(slug):
    presentation = Presentation.query.filter_by(is_visible=True,
                                                slug=slug).first()
    if presentation:
        return render_template('/presentations/' + presentation.filename)
    abort(404)
```

The first function we wrote, `list_public_presentations`, performs a PostgreSQL database query through SQLAlchemy for all presentations with the `is_visible field` set to `True` then passes the results to the template renderer. The second function, `presentation`, only renders the presentation if the URL slug matches an existing presentation and for that presentation the `is_visible field` is `True`. Otherwise an HTTP 404 status code is returned.

One more step in `cyoa/cyoa/views.py`. Add the following line as a new import to the top of the file so that our new code can use the `Presentation` database model for the queries in the functions we just wrote:

```
from .models import Wizard

from . import app, redis_db, socketio, login_manager
from .models import Presentation

client = TwilioRestClient()
```

Finally, create a new list template for the presentations. Call this file `cyoa/cyoa/templates/list_presentations.html`.

```
{% extends "base.html" %}
{% block content %}
<div class="container">
  <div class="row">
    <div class="col-md-10">
      <h1>Available presentations</h1>
      {% for p in presentations %}
        <p><a href="{{ url_for('presentation', slug=p.slug) }}">{{ p.name }}</a></p>
      {% else %}
        No public presentations found.
      {% endfor %}
    </div>
  </div>
</div>
{% endblock %}
```

We need to move our `cyoa.html` default template into the `cyoa/cyoa/templates/presentations/` folder because our `list_public_presentations` function now looks in that folder instead of the `cyoa/yoa/templates/` folder. Create a new directory within `cyoa/cyoa/templates` called `presentations`:

```
mkdir cyoa/templates/presentations/
```

Now go to the `cyoa/cyoa/templates/` directory and run the following move command.

```
mv cyoa.html presentations/
```

Be sure to store your new presentations within the `cyoa/templates/presentations/` folder from now on.

Check out the simple listing of presentations available to the audience. Go to http://localhost:5001 and you'll see the list of visible presentations.

All Prepared for Part 3!

We now have a working Wizards Only set of screens for managing our presentations. There's a big elephant in the room though with our current application. Each presentation has a checkbox to enable websockets-based voting to complement SMS voting. However, we haven't coded the ability for presentation watchers to vote via web browsers just yet. In part three of this

series, we'll conclude by adding that new voting functionality so that our project is complete.

Choose Your Own Adventure Presentations: Wizard Mode Part 3 of 3 with Flask, Reveal.js and WebSockets

You have coded your way through the original Choose Your Own Adventure Presentations story, the Wizards Only gatekeeper and the Web Forms trials blog posts. Now it's time to pull out our magical wands for one more trick and complete our application-building quest.

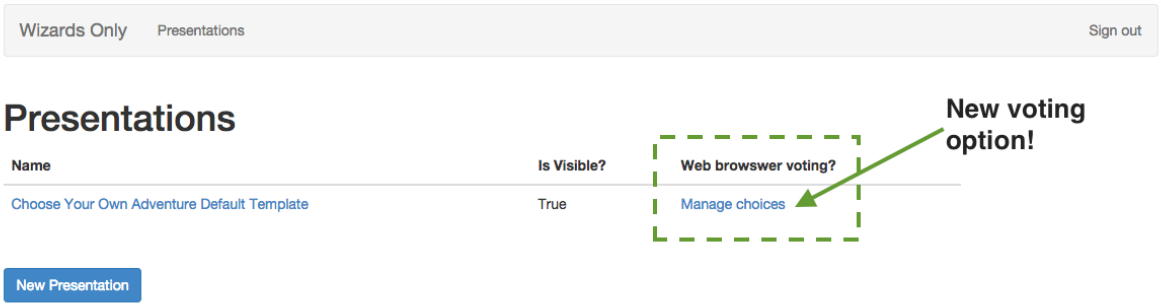
Voting with a wand (or smartphone)

In this final tutorial we'll wrap up our Flask application with a new ability that will allow the audience to vote with a web browser on their wand... or smartphone. We will write code to keep track of audience votes from web browsers using WebSockets. The new browser-based voting can augment our existing SMS-based voting for presentations when cell signals aren't working well.

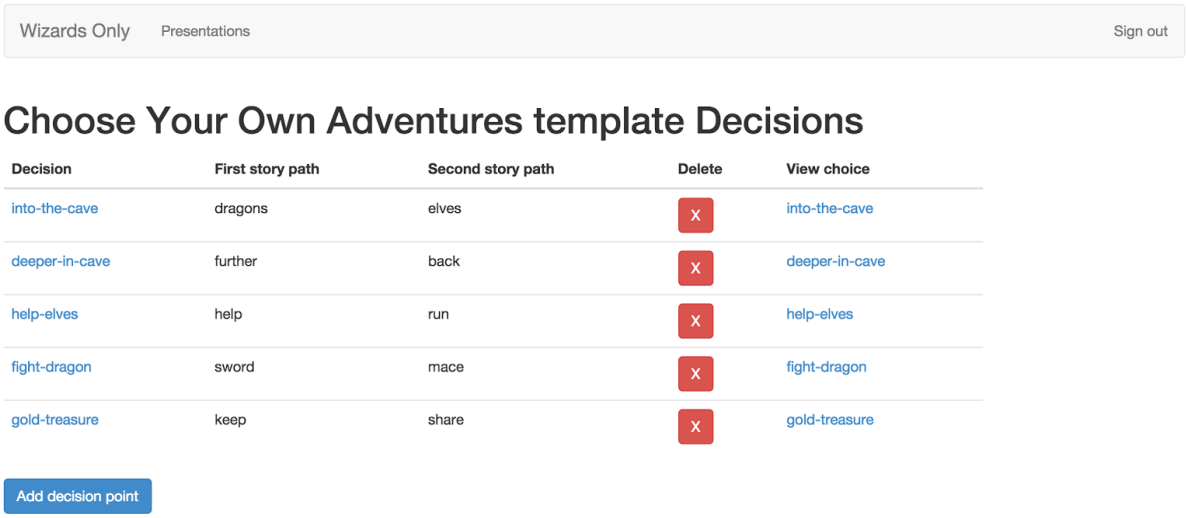
Don that wizard's cloak one more time and get ready to write a bit more Python code as we finish out our Choose Your Own Adventure Presentations application.

Manage Decisions View

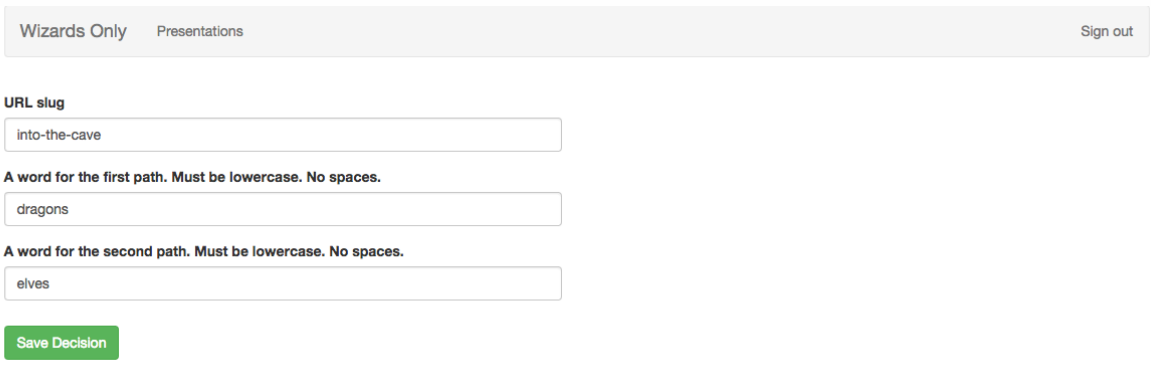
We need to create new Wizards Only screens to set up the web browser voting when we want to enable it for presentations. Note that we don't have to enable voting via a web browser, we can continue to just use SMS for votes. However, these new screens simply give us an option to replace or augment SMS voting which is great if the cell phone service does not work well in a venue. After we write the code in this section and fire up our development server, our new admin screens should look like these screenshots below.



When we create a presentation there will be an option to manage web browser-based voting as shown above. The Manage choices link takes the wizard user to a new screen where decisions that have been created can be edited, deleted or created.



Decisions can be created and saved via the simple form as seen below.



Time to get into the new code we need to write to transform the above screenshots from images into a part of our working application. Crank open the existing `cyoa/cyoa/models.py` file in your favorite editor. We are going

to add the first highlighted line to the Presentation model that represents a foreign key to the new Decision model. The Decision model will hold the slugs to the webpages that will allow someone in the audience to vote on a decision. Add the new line to Presentation and create the new Decision model as shown below.

```
class Presentation(db.Model):
    """
        Contains data regarding a single presentation.
    """
    __tablename__ = 'presentations'
    id = db.Column(db.Integer, primary_key=True)
    name = db.Column(db.String(64), unique=True)
    slug = db.Column(db.String(128), unique=True)
    filename = db.Column(db.String(256))
    is_visible = db.Column(db.Boolean, default=False)
    decisions = db.relationship('Decision', lazy='dynamic')

    def __repr__(self):
        return '<Presentation %r>' % self.name


 class Decision(db.Model):
    """
        A branch in the storyline that an audience member can vote on.
        Must map directly into what is stored in Redis.
    """
    __tablename__ = 'choices'
    id = db.Column(db.Integer, primary_key=True)
    slug = db.Column(db.String(128))
    first_path_slug = db.Column(db.String(128))
    second_path_slug = db.Column(db.String(128))
    presentation = db.Column(db.Integer, db.ForeignKey('presentations.id'))

    def __repr__(self):
        return '<Decision %r>' % self.slug
```

The new models code above allows us to save and manipulate web browser-based decisions that can be associated with specific presentations.

Next we need to update the `cyoa/cyoa/forms.py` file with a new `DecisionForm` class. Within `cyoa/cyoa/forms.py` append the following new form class as highlighted below.

```
from flask.ext.wtf import Form
from wtforms import StringField, PasswordField, BooleanField, SubmitField,
                    DateField, IntegerField
from wtforms.validators import Required, Length, Regexp, EqualTo
from wtforms import ValidationError
from .models import Wizard


class LoginForm(Form):
    wizard_name = StringField('Wizard Name',
                              validators=[Required(), Length(1, 32)])
    password = PasswordField('Password', validators=[Required(),
```

```
                                                Length(1, 32)])

    def validate(self):
        if not Form.validate(self):
            return False
        user = Wizard.query.filter_by(wizard_name=self.
                                      wizard_name.data).first()
        if user is not None and not user.verify_password(self.password.data):
            self.password.errors.append('Incorrect password.')
            return False
        return True


class PresentationForm(Form):
    name = StringField('Presentation name', validators=[Required(),
                                                        Length(1, 60)])
    filename = StringField('File name', validators=[Required(),
                                                    Length(1, 255)])
    slug = StringField('URL slug', validators=[Required(),
                                               Length(1, 255)])
    is_visible = BooleanField()


class DecisionForm(Form):
    slug = StringField('URL slug', validators=[Required(),
                                               Length(1, 128)])
    first_path_slug = StringField('A word for the first path. Must be '
                                  'lowercase. No spaces.',
                                  validators=[Required(), Length(1, 64),
                                              Regexp('[a-z0-9] ', message=
                                              'Choice must be lowercase '
                                              'with no whitespace.')])
    second_path_slug = StringField('A word for the second path. Must be '
                                   'lowercase. No spaces.',
                                   validators=[Required(), Length(1, 64),
                                               Regexp('[a-z-0-9] ', message=
                                               'Choice must be lowercase '
                                               'with no whitespace.')])
```

The `DecisionForm` is used to create and edit decisions through the user interface. We've included some basic validation to ensure proper URL slugs are input by the user.

The next file that is critical for getting our web browser-based voting up and running is `cyoa/cyoa/wizard_views.py`. The changes we are going to make in this file will allow us to modify the decisions found in presentations so users can only vote in the web browser on choices we've created for them. In part two of our tutorial, we included stub functions in this `wizard_views.py` file knowing that we'd flesh them out in this post. Make sure to remove the pass keyword from the body of those functions and insert the highlighted code shown below.

```
from flask import render_template, redirect, url_for
from flask.ext.login import login_required
```

```
from . import app, db
from .models import Presentation, Decision
from .forms import PresentationForm, DecisionForm


@app.route('/wizard/presentations/')
@login_required
def wizard_list_presentations():
    presentations = Presentation.query.all()
    return render_template('wizard/presentations.html',
                           presentations=presentations)


@app.route('/wizard/presentation/', methods=['GET', 'POST'])
@login_required
def wizard_new_presentation():
    form = PresentationForm()
    if form.validate_on_submit():
        presentation = Presentation()
        form.populate_obj(presentation)
        db.session.add(presentation)
        db.session.commit()
        return redirect(url_for('wizard_list_presentations'))
    return render_template('wizard/presentation.html', form=form, is_new=True)


@app.route('/wizard/presentation/<int:id>/', methods=['GET', 'POST'])
@login_required
def wizard_edit_presentation(id):
    presentation = Presentation.query.get_or_404(id)
    form = PresentationForm(obj=presentation)
    if form.validate_on_submit():
        form.populate_obj(presentation)
        db.session.merge(presentation)
        db.session.commit()
        db.session.refresh(presentation)
    return render_template('wizard/presentation.html', form=form,
                           presentation=presentation)


@app.route('/wizard/presentation/<int:pres_id>/decisions/')
@login_required
def wizard_list_presentation_decisions(pres_id):
    presentation = Presentation.query.get_or_404(pres_id)
    return render_template('wizard/decisions.html', presentation=presentation,
                           decisions=presentation.decisions.all())


@app.route('/wizard/presentation/<int:pres_id>/decision/',
           methods=['GET', 'POST'])
@login_required
def wizard_new_decision(pres_id):
    form = DecisionForm()
    if form.validate_on_submit():
        decision = Decision()
        form.populate_obj(decision)
        decision.presentation = pres_id
        db.session.add(decision)
        db.session.commit()
        return redirect(url_for('wizard_list_presentation_decisions',
                                pres_id=pres_id))
    return render_template('wizard/decision.html', form=form, is_new=True,
                           presentation_id=pres_id)
```

```
@app.route('/wizard/presentation/<int:presentation_id>/decision/'
           '<int:decision_id>/', methods=['GET', 'POST'])
@login_required
def wizard_edit_decision(presentation_id, decision_id):
    decision = Decision.query.get_or_404(decision_id)
    form = DecisionForm(obj=decision)
    if form.validate_on_submit():
        form.populate_obj(decision)
        decision.presentation = presentation_id
        db.session.merge(decision)
        db.session.commit()
        db.session.refresh(decision)
        return redirect(url_for('wizard_list_presentation_decisions',
                        pres_id=presentation_id))
    return render_template('wizard/decision.html', form=form,
                           decision=decision, presentation_id=presentation_id)


@app.route('/wizard/presentation/<int:pres_id>/decision/'
           '<int:decision_id>/delete/')
@login_required
def wizard_delete_decision(pres_id, decision_id):
    presentation = Presentation.query.get_or_404(pres_id)
    decision = Decision.query.get_or_404(decision_id)
    db.session.delete(decision)
    db.session.commit()
    return redirect(url_for('wizard_list_presentation_decisions',
                    pres_id=presentation.id))
```

We added code to list, create, edit and delete decisions in the system. These are standard operations for an administrative interface that any self-respecting wizard would expect.

Alright, that's all the Python code we need at the moment for the new Wizards Only screens. Now we need to create some new templates to generate the HTML for our decision screens. Create a new file named `cyoa/cyoa/templates/wizard/decisions.html` with the following markup.

```
{% extends "base.html" %}

{% block nav %}
  {% include "nav.html" %}
{% endblock %}

{% block content %}
<div class="container">
    <div class="row">
        <div class="col-md-10">
            <h1>{{ presentation.name }} Decisions</h1>
            {% if decisions|length == 0 %}
                No web browser voting enabled for
                <em>{{ presentation.name }}</em>.
                <a href="{{ url_for('wizard_new_decision', pres_id=presentation.id) }}">Add a decis
ion point for this presentation</a>.
            {% else %}
```

```
                <table class="table">
                    <thead>
                        <tr>
                            <th>Decision</th>
                            <th>First story path</th>
                            <th>Second story path</th>
                            <th>Delete</th>
                            <th>View choice</th>
                        </tr>
                    </thead>
                    <tbody>
                    {% for d in decisions %}
                        <tr>
                            <td><a href="{{ url_for('wizard_edit_decision', presentation_id=present
ation.id, decision_id=d.id) }}">{{ d.slug }}</a></td>
                            <td>{{ d.first_path_slug }}</td>
                            <td>{{ d.second_path_slug }}</td>
                            <td><a href="{{ url_for('wizard_delete_decision', pres_id=presentatio
n.id, decision_id=d.id) }}" class="btn btn-danger">X</a></td>
                            <td>{{ d.slug }}</td>
                        </tr>
                    {% endfor %}
                    </tbody>
                </table>
            {% endif %}
            <div class="btn-top-margin">
            <a href="{{ url_for('wizard_new_decision', pres_id=presentation.id) }}" class="btn bt
n-primary">Add decision point</a>
            </div>
        </div>
    </div>
</div>
{% endblock %}
```

The above template markup loops through existing decisions and displays each one's name and first and second story paths along with options to delete or view the decision's webpage. If no decisions are returned from the database for the selected presentation, then a simple explanation will show "No web browser voting enabled for [presentation name]." There must be decision points created in the user interface for the browser-based voting to work.

There also needs to be a template file for creating new decisions and editing existing ones. Create the file `cyoa/cyoa/templates/wizard/decision.html` and insert the following markup. Make sure you've named this file without an 's' at the end of "decision" so it doesn't overwrite the previous template we just created.

```
{% extends "base.html" %}

{% block nav %}
    {% include "nav.html" %}
{% endblock %}

{% block content %}
<div class="container">
```

```
    <div class="row">
        <div class="col-md-6">
            {% from "partials/_formhelpers.html" import render_field %}
            {% if is_new %}
            <form action="{{ url_for('wizard_new_decision', pres_id=presentation_id) }}"
                  method="post">
            {% else %}
            <form action="{{ url_for('wizard_edit_decision', presentation_id=presentation_id, decis
ion_id=decision.id) }}" method="post">
            {% endif %}
                <div>
                    {{ form.csrf_token }}
                    {{ render_field(form.slug) }}
                    {{ render_field(form.first_path_slug) }}
                    {{ render_field(form.second_path_slug) }}
                </div>
                <div>
                <input type="submit" class="btn btn-success btn-top-margin"
                       value="Save Decision"></input>
                </div>
            </form>
        </div>
    </div>
</div>
{% endblock %}
```

With the above template we have a way to create and edit decisions. The template is generated with a form submit to either create a new decision if the "New Decision" button was clicked or edit the existing decision when modifying an existing decision.

Finally, it's time to test out our new code! Create the new Decision database table by running the following command at the base directory of our project.

```
(cyoa)$ python manage.py syncdb
```

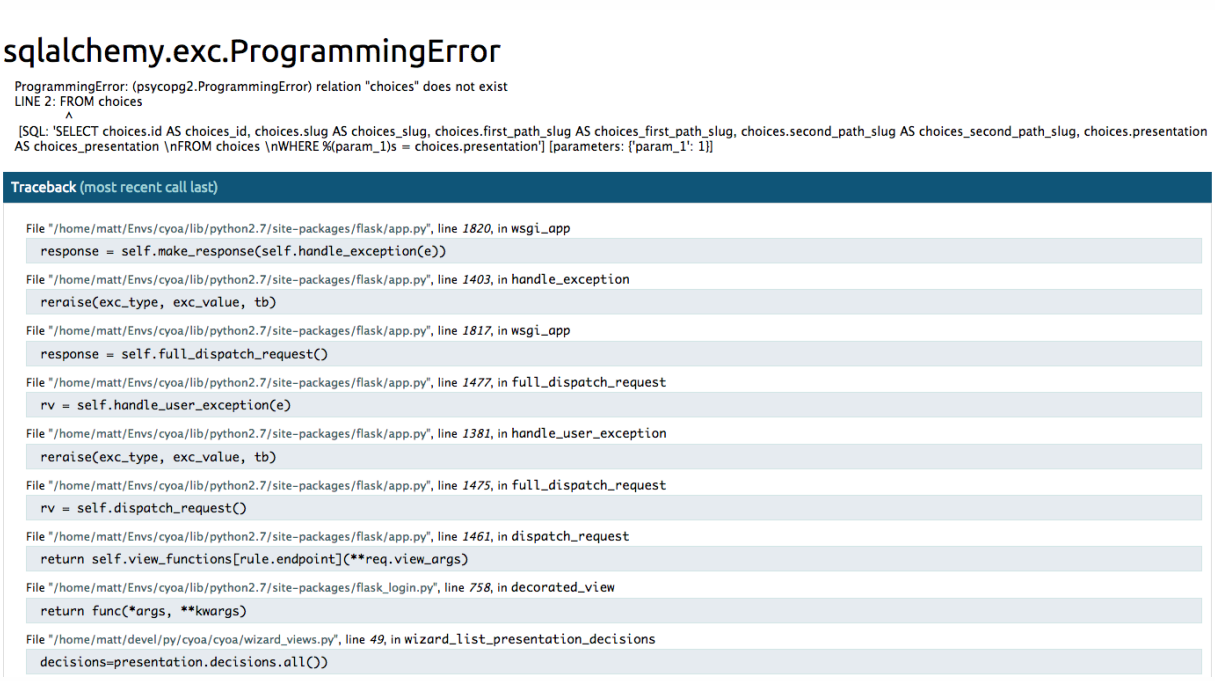
Now run the development server with the following command as we've performed in previous blog posts.

```
(cyoa)$ python manage.py runserver
```

Head to http://localhost:5001/wizard to check out the current version of our application.

So far so good. Sign in using the defaults "gandalf" as a username and "thegrey" as the password that were created in part 1 of the tutorial.

If there are existing presentations in your application, click on the "Manage choices" link for one of the presentations, or create a new presentation then click the link. Unfortunately, upon clicking "Manage choices" we will suddenly get the following error page...



Uh oh. What's happening here? It looks like the new foreign key relationship in the `Presentation` table is causing a database error. Although we created the new `Decision` table with the `syncdb` command, it did not create the foreign key relationship column in the Presentation table.

How do we fix this problem? We need to ensure the Presentation table has the appropriate column in the database. To accomplish that we have to:

- Use a library to perform a schema migration based on our updated SQLAlchemy models
- Add the column manually to the database with an ALTER TABLE statement
- Drop and recreate the database and re-sync the database tables.

For simplicity's sake, in this post we'll use the third method of dropping and recreating the database. Note that unfortunately the existing wizards and presentations in the database will be deleted when we blow away the database so we will also walk through recreating them.

Kill the development server process with `Ctrl-C` and execute the following commands to recreate the PostgreSQL database.

```
(cyoa)$ dropdb cyoa

(cyoa)$ createdb cyoa

(cyoa)$ python manage.py syncdb
```

We also need to create a new Wizard user in the database since the previous one was deleted.

```
(cyoa)$ python manage.py shell
>>> db.session.add(Wizard('gandalf', 'thegrey'))
>>> db.session.commit()
>>> exit()
```

Finishing up browser voting

With our new Decision model in place, let's finish out this tutorial by adding the browser-based voting functionality. Open up `cyoa/cyoa/views.py` and update the following highlighted lines.

```
import cgi
from flask import render_template, abort, request
from flask import redirect, url_for
from flask.ext.login import login_user, logout_user, login_required, \
                            current_user
from jinja2 import TemplateNotFound
from twilio import twiml
from twilio.rest import TwilioRestClient

from .config import TWILIO_NUMBER
from .forms import LoginForm

from .models import Wizard, Decision
from . import app, redis_db, socketio, login_manager
from .models import Presentation

client = TwilioRestClient()

@login_manager.user_loader
def load_user(userid):
    return Wizard.query.get(int(userid))


@app.route('/', methods=['GET'])
def list_public_presentations():
    presentations = Presentation.query.filter_by(is_visible=True)
    return render_template('list_presentations.html',
                           presentations=presentations)


@app.route('/<slug>/', methods=['GET'])
def presentation(slug):
    presentation = Presentation.query.filter_by(is_visible=True,
                                                slug=slug).first()
    if presentation:
        return render_template('/presentations/' + presentation.filename)
    abort(404)


@app.route('/cyoa/twilio/webhook/', methods=['POST'])
def twilio_callback():
    to = request.form.get('To', '')
    from_ = request.form.get('From', '')
    message = request.form.get('Body', '').lower()
```

```
    if to == TWILIO_NUMBER:
        redis_db.incr(cgi.escape(message))
        socketio.emit('msg', {'div': cgi.escape(message),
                              'val': redis_db.get(message)},
                      namespace='/cyoa')
    resp = twiml.Response()
    resp.message("Thanks for your vote!")
    return str(resp)


@app.route('/wizard/', methods=['GET', 'POST'])
def sign_in():
    form = LoginForm()
    if form.validate_on_submit():
        wizard = Wizard.query.filter_by(wizard_name=
                                        form.wizard_name.data).first()
        if wizard is not None and wizard.verify_password(form.password.data):
            login_user(wizard)
            return redirect(url_for('wizard_list_presentations'))
    return render_template('wizard/sign_in.html', form=form, no_nav=True)


@app.route('/sign-out/')
@login_required
def sign_out():
    logout_user()
    return redirect(url_for('sign_in'))


@app.route('/<presentation_slug>/vote/<decision_slug>/', methods=['GET'])
def decision(presentation_slug, decision_slug):
    presentations = Presentation.query.filter_by(slug=presentation_slug)
    if presentations.count() > 0:
        presentation = presentations.first()
        decision = Decision.query.filter_by(presentation=presentation.id,
                                            slug=decision_slug).first()
        return render_template('decision.html', presentation=presentation,
                               decision=decision)
    return render_template("404.html"), 404


@app.route('/<presentation_slug>/vote/<decision_slug>/<choice_slug>/',
           methods=['GET'])
def web_vote(presentation_slug, decision_slug, choice_slug):
    presentations = Presentation.query.filter_by(slug=presentation_slug)
    if presentations.count() > 0:
        presentation = presentations.first()
        decision = Decision.query.filter_by(presentation=presentation.id,
                                            slug=decision_slug).first()
        if decision:
            votes = redis_db.get(choice_slug)
            return render_template('web_vote.html', decision=decision,
                                   presentation=presentation, votes=votes,
                                   choice=choice_slug)
    return render_template("404.html"), 404


 def broadcast_vote_count(key):
    total_votes = 0
    if redis_db.get(key):
        total_votes += int(redis_db.get(key))
    total_votes += len(socketio.rooms['/cyoa'][key])
    socketio.emit('msg', {'div': key, 'val': total_votes},
                  namespace='/cyoa')
```

The above code creates two new routes for displaying voting choices and decisions built within the Wizard interface. These decision pages allow an audience member to vote by clicking one of two buttons on a page and staying on the voting page. Those votes are calculated just like SMS votes as long as the user stays on the page.

An active WebSocket connection increments the vote counter for that choice in Redis and when a user leaves the page the websocket connection is cleaned up and the Redis value for that choice is decremented. Note however one downside of the web browser-based voting is that the WebSocket connection may not be immediately recognized as closed. It can take a few seconds before the WebSocket is cleaned up and the vote counter decremented.

We have a couple more steps to wrap up the application's browser-voting functionality. Modify the `cyoa/cyoa/websockets.py` file by adding the highlighted code shown below.

```
from flask.ext.socketio import emit
from flask.ext.socketio import join_room, leave_room

from . import socketio
from .views import broadcast_vote_count


@socketio.on('connect', namespace='/cyoa')
 def ws_connect():
    pass


@socketio.on('disconnect', namespace='/cyoa')
 def ws_disconnect():
    pass


@socketio.on('join', namespace='/cyoa')
 def on_join(data):
    vote = data['vote']
    join_room(vote)
    broadcast_vote_count(vote)
```

The above code handles the websockets connections and determines the decision chosen by a user.

There is one small change to the Wizard decisions page that'll make our lives easier. We want to be able to immediately view a decision after it's been created. To accomplish this task, edit the `cyoa/cyoa/templates/decisions.html` file and update the following single highlighted line.

```
{% extends "base.html" %}
{% block nav %}
    {% include "nav.html" %}
{% endblock %}

{% block content %}
<div class="container">
    <div class="row">
        <div class="col-md-10">
            <h1>{{ presentation.name }} Decisions</h1>
            {% if decisions|length == 0 %}
                No web browser voting enabled for
                <em>{{ presentation.name }}</em>.
                <a href="{{ url_for('wizard_new_decision', pres_id=presentation.id) }}">Add a decis
ion point for this presentation</a>.
            {% else %}
                <table class="table">
                    <thead>
                        <tr>
                            <th>Decision</th>
                            <th>First story path</th>
                            <th>Second story path</th>
                            <th>Delete</th>
                            <th>View choice</th>
                        </tr>
                    </thead>
                    <tbody>
                    {% for d in decisions %}
                        <tr>
                            <td><a href="{{ url_for('wizard_edit_decision', presentation_id=present
ation.id, decision_id=d.id) }}">{{ d.slug }}</a></td>
                            <td>{{ d.first_path_slug }}</td>
                            <td>{{ d.second_path_slug }}</td>
                            <td><a href="{{ url_for('wizard_delete_decision', pres_id=presentatio
n.id, decision_id=d.id) }}" class="btn btn-danger">X</a></td>
                            <td><a href="{{ url_for('decision', presentation_slug=presentation.slu
g, decision_slug=d.slug) }}" target="_blank">{{ d.slug }}</a></td>
                        </tr>
                    {% endfor %}
                    </tbody>
                </table>
            {% endif %}
            <div class="btn-top-margin">
            <a href="{{ url_for('wizard_new_decision', pres_id=presentation.id) }}" class="btn bt
n-primary">Add decision point</a>
            </div>
        </div>
    </div>
</div>
{% endblock %}
```

The above one line change in `decisions.html` allows a wizard to view the decision she's created by opening a new browser window with the decision.

We're almost there – just one more template file to build! Create one more new template named `cyoa/cyoa/templates/web_vote.html` with the following contents.

```
{% extends "base.html" %}
```

```
{% block content %}
<div class="container">
  <div class="row">
    <div class="col-md-6">
      <h2>You've chosen <em>{{ choice }}</em>. Stay on
          this page until all the votes are counted.</h2>
      <h1><span id="vote-counter"></span> votes for
          {{ choice }}.</h1>
    </div>
  </div>
</div>
{% endblock %}


{% block js_body %}
<script type="text/javascript"
        src="http://code.jquery.com/jquery-1.11.1.min.js"></script>
<script type="text/javascript"
        src="//cdnjs.cloudflare.com/ajax/libs/socket.io/0.9.16/socket.io.min.js"></script>

<script type="text/javascript">
    $(document).ready(function() {
        namespace = '/cyoa';
        var websocket = io.connect('http://' + document.domain + ':'
                                   location.port + namespace);

        websocket.emit('join', {'vote': '{{ choice }}'});

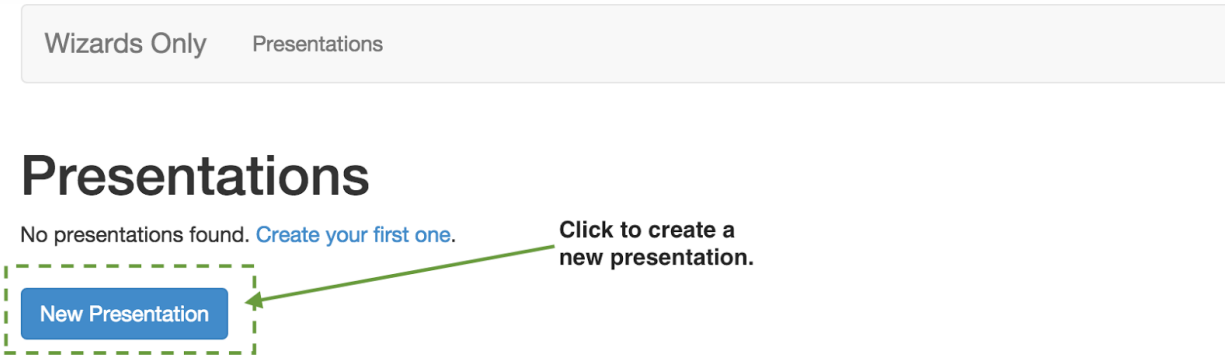
        websocket.on('msg', function(msg) {
            var voteCounter = $('#vote-counter').html(msg.val);
        });
    });
</script>
{% endblock %}
```

Let's give our application a final spin to see the web browser-based voting in action.

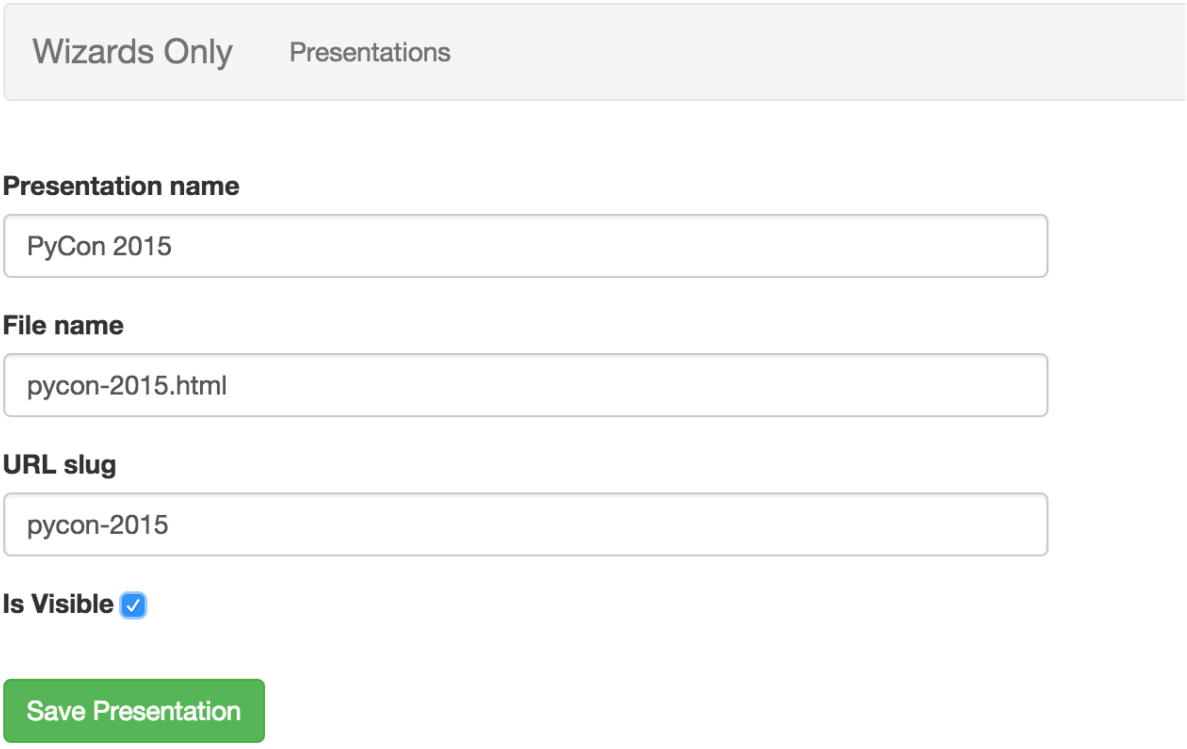
Run the development server with the following command as we've performed in previous blog posts.

```
(cyoa)$ python manage.py runserver
```

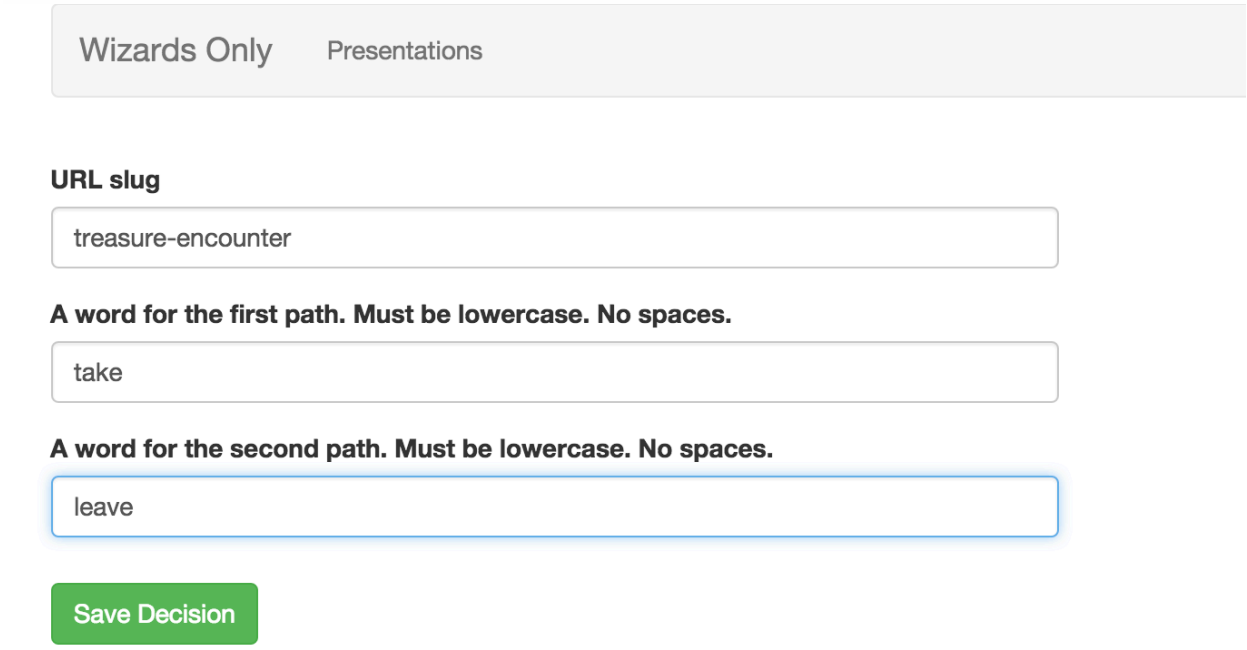
Head to http://localhost:5001/wizard to log in with our wizard account. We'll create a new presentation and add decisions to it through the new user interface to test it out.



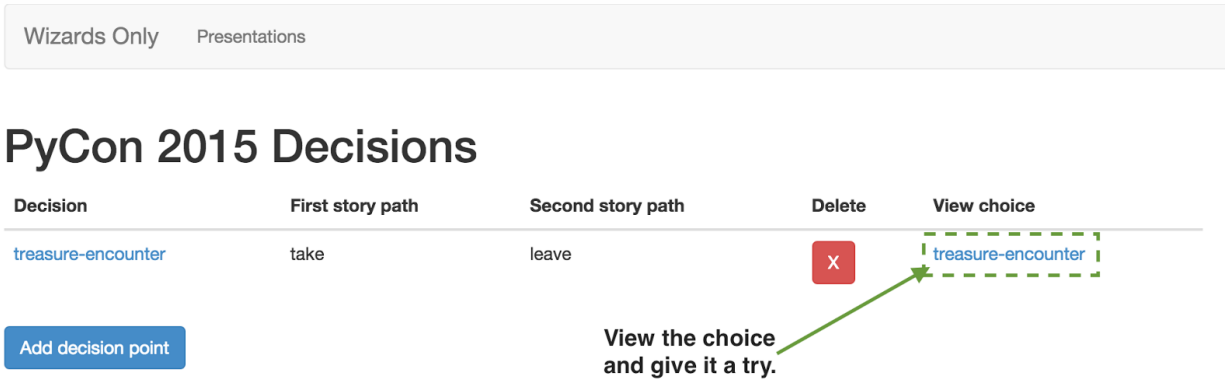
Add a new presentation based with the following data or based on a presentation you've already built.



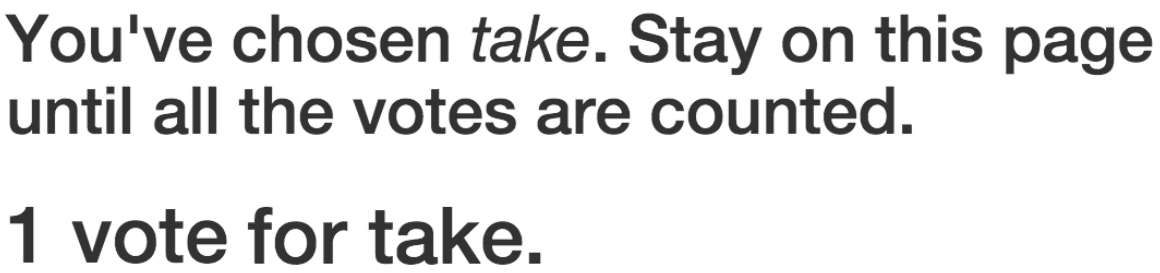
Next create a decision point using the new code we wrote in this tutorial. This decision will allow the audience to vote with their web browser. Create a decision like the following and save it.



Click the link in the rightmost column to view the new decision.



Select one of the two options on the screen and your vote will be tallied along with any other browser and SMS-based votes.



You're voting for this choice via websocket just by staying on this page! This type of voting is a huge help for when cellular service doesn't work in a room or you're giving a presentation internationally where many folks don't have an active cell phone plan, such as with PyCon 2015 in Canada.

Now we have the ability to vote both with SMS and web browsing in our Choose Your Own Adventure presentations! If there was an issue you ran into along the way that you couldn't figure out remember that there is a tutorial-step-6 tag that contains the finished code for this blog post.

Wizard Mode Engaged!

Our Wizard Mode is complete. We now have far more control over presentations and a new mechanism for audience voting via web browsers in addition to SMS. With our battle-ready upgrades, we're set to use them in a live technical talk. In fact, this is the code that Kate Heddleston and I used for the talks Choose Your Own WSGI Deployment Adventure at PyCon 2015.

Let me know what new Choose Your Own Adventure presentation stories you come up with or open a pull request to improve the code base.

Contact me via:

- Email: makai@twilio.com
- GitHub: Follow mattmakai for repository updates
- Twitter: @mattmakai