Building a Python Flask Website

A beginner-friendly guide

PythonHow.com

Preface

This book contains a quick guide on understanding and using the Python flask framework for building a simple website. This tutorial does not intend to be a complete guide on the flask framework, but a complete guide on creating a static website with Python from scratch to deployment on a production server. The book is great for people who have never programmed before and who want to get started with Python for building web applications.

Building a Python Flask Website

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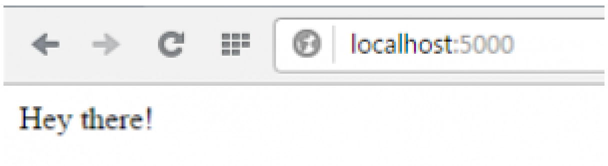
Your first Flask website

Why not making a website before you even learn how to make a website? Just something as simple as this:



Hey there!

Yes, it’s just a page with some plain text, but it is still called a website and that’s how it starts. Python is concise so it takes only seven lines of code to build what you see in the screenshot. Let’s do it.

Insert the following lines of Python code inside an empty text file, and name the file something like `hello.py.`

```
from flask import Flask

app = Flask(__name__)

@app.route('/')
def home():
return "Hey there!"

if __name__ == '__main__':
app.run(debug=True)
```

As you can see we are importing the `flask` library in the first line. If you don’t have that library installed, you will get an error. To install flask, simply type in `pip install flask` your computer **terminal/command line.** Once you have made sure *flask* is installed, simply run the *hello.py* script.

Once you run the script, your website should be now live on your local machine and it can be viewed by visiting `localhost:5000` in your browser.

Let’s move on!

How building a website with Python works

Before building something more attractive instead of just a webpage with plain text, let’s first make sure you understand how generating websites with Python works.

Think about the user typing in your website URL in their browser.

When the user enters the URL in the browser, they are making a request to the web server.

As a developer, you would have to write some Python code to handle requests and deal with CGI which is a standard environment that Python and other web development programming languages use to create web pages dynamically. And you would have to write the same code over and over again for every web app that you built.

Now, because that is a repetitive task, someone put all that code together and created a bunch of Python files. These bunch of files were called *flask*. So, *flask* is a framework which when loaded in Python automatically executes the routine code and let’s you focus on the specific parts of your website. When we type in *pip install flask* in the command line, we are downloading the flask framework from its online repositories and when we *import flask* we are making the framework available in our current script and we can use its features easily there.

Now, before making a more advanced website, let’s go and explain all the lines of the code we have so far in the next lesson of the tutorial.

How a Flask app works

In this lesson you will learn how a flask web app works. The code we have so far is a typical flask script that builds a simple website. So, we're going to explain what that code does line by line. This is what we have so far:

```
from flask import Flask

app = Flask(__name__)

@app.route('/')
def home():
return "Hey there!"

if __name__ == '__main__':
app.run(debug=True)
```

In **line 1** you are making available the code you need to build web apps with flask. `flask` is the framework here, while `Flask` is a Python class datatype. In other words, *Flask* is the prototype used to create instances of web application or web applications if you want to put it simple.

So, once we import *Flask*, we need to create an instance of the *Flask* class for our web app. That's what **line 3** does. `__name__` is a special variable that gets as value the string `"__main__"` when you're executing the script. We'll go back to that in a moment.

In **lines 5-7** we are defining a function that returns the string "Hey there!". That function is mapped to the home `'/'` URL. That means when the user navigates to `localhost:5000`, the *home* function will run and it will return its output on the webpage. If the input to the route method was something else, let's say `'/about/'`, the function output would be shown when the user visited `localhost:5000/about/`. How practical is that?

Then we have the mysterious **lines 9 and 10**. Something you should know is that Python assigns the name `"__main__"` to the script when the script is executed. If the script is imported from another script, the script keeps it given name (e.g. hello.py). In our case we are executing the script. Therefore, `__name__` will be equal to `"__main__"`. That means the if conditional statement is satisfied and the *app.run()* method will be executed. This technique allows the programmer to have control over script's behavior.

Notice also that we are setting the `debug` parameter to `true`. That will print out possible Python errors on the web page helping us trace the errors. However, in a production environment, you would want to set it to `False` as to avoid any security issues.

So far, so good!

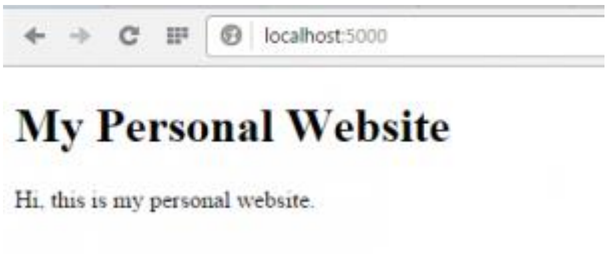
We have a running website with some content returned by the Python function. As you can imagine, returning plain strings from a function doesn't take us anywhere far.

If you want to make something more serious and more visually appealing, you would want to incorporate HTML files along your Python file and have your Python code return HTML pages instead of plain strings.

You will do just that in the next lesson.

HTML templates in flask

In this part of the tutorial, you will learn to return HTML pages through your Python script using the flask `render_template` method. At the end of this lesson, your website will look like this:



My Personal Website

Hi, this is my personal website.

As you see, we don’t have plain text anymore, but text with various formats. That is made possible by returning an HTML template instead of a plain Python string.

Let’s see how I did that.

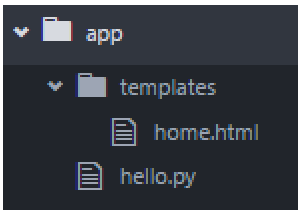
Create an empty file, name it something like `home.html` and put the following HTML code inside it:

```
<!DOCTYPE html>
<html>
<body>
<h1>My Personal Website</h1>
<p>Hi, this is my personal website.</p>
</body>
</html>
```

As you already know HTML is a markup language used to render webpages. Try to remember these three things about creating HTML pages:

- An HTML document must start with a declaration that specifies the document type: *<!DOCTYPE html>*.
- The HTML document itself always begins with *<html>* and ends with *</html>*.
- The visible part of the HTML document is between *<body>* and *</body>*. The area outside of that is used to reference Javascript files, CSS, or other features.

The flask framework has been written in a way so that it looks for HTML template files in a folder that should be named `templates`. So, you should create such an empty folder and then put all the HTML templates in there. Here is how the web app directory tree should like at this point:



So, the Python script stays outside of the templates folder.

Let's now edit the Python code so that it reads the HTML template and returns it to the webpage. Here is the updated version:

```
from flask import Flask, render_template

app = Flask(__name__)

@app.route('/')
def home():
return render_template('home.html')

if __name__ == '__main__':
app.run(debug=True)
```

The highlighted lines are the ones to have been updated. And what we did is we imported the `render_template` method from the flask framework and then we passed an HTML file to that method. The method will generate a *jinja2* template object out of that HTML and return it to the browser when the user visits associated URL.

So, going to *localhost:5000* now should display the webpage shown in screenshot at the beginning of this lesson.

Great! Let's expand our website even more.

Adding more pages to the website

In this lesson you will learn how to add more pages to your flask website.

We will quickly add an *About* page.

For that, you need to create an `about.html` file inside the `templates` folder. The HTML code would be as follows:

```
<!DOCTYPE html>
<html>
<body>
<h1>About me</h1>
<p>This is a portfolio site about anything that can be put in a portfolio.</p>
</body>
</html>
```

Second, you need to render the HTML with Python by adding a second function to the `hello.py` Python script.

```
from flask import Flask, render_template

app = Flask(__name__)

@app.route('/')
def home():
return render_template('home.html')

@app.route('/about/')
def about():
return render_template('about.html')

if __name__ == '__main__':
app.run(debug=True)
```

Run the Python script and go to `localhost:5000/about` and you will see the new page.

That's it! You could add more pages by adding more Python functions to your script.

One last thing we could improve before we close this lesson would be to wrap our heading and paragraph tags inside *div*tags. That will keep them grouped inside the same section in the HTML document so that we can later apply CSS styling to that section. Here is how the updated `about.html` would look like:

```
<!DOCTYPE html>
<html>
<body>
<div class="about">
<h1>About me</h1>
<p>This is a portfolio site about anything that can be put in a portfolio.</p>
</div>
</body>
</html>
```

Please do the same for the `home.html` document as well.

```
<!DOCTYPE html>
<html>
<body>
<div class="home">
<h1>About me</h1>
<p>This website was built with Python via the Flask framework.</p>
</div>
</body>
</html>
```

Running the Python script should output the same results as before when opening the two URLs.

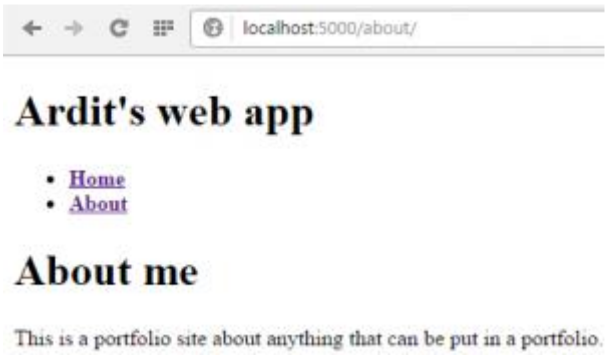
Cool, but there is something missing that you have probably started to notice and that is the website navigation menu.

Let’s add one in the next lecture.

Adding a navigation menu to the website

At this point we have two HTML pages and a Python script that renders those HTML pages to two different URLs – the *home*and the *about* URL.

Now we need to add a menu so that the user can easily navigate through the webpages by just clicking their links. After we have done that the two pages will look like this:

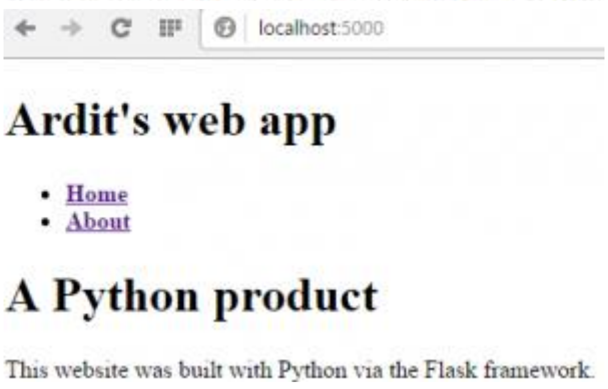

localhost:5000/about/

Ardit's web app

- Home
- About

About me

This is a portfolio site about anything that can be put in a portfolio.


localhost:5000

Ardit's web app

- Home
- About

A Python product

This website was built with Python via the Flask framework.

If you look carefully, you will notice that the two webpages above share a common area which consists of the header (i.e.*Ardit's web app*) and the navigation menu.

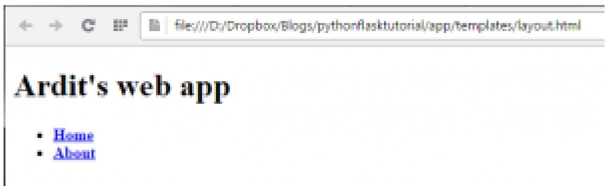
To create that area in each page, we could add the HTML code that generates such a header to each of our HTML files. However, a smarter thing to do would be to create a parent HTML template which our two child templates could inherit the code from. Then we could simply link to that parent layout from each HTML page to inherit its code.

Let's see how this is done.

We would need to create a new HTML page and call it something like `layout.html`:

```
<!DOCTYPE html>
<html>
<body>
<header>
<div class="container">
<h1 class="logo">Ardit's web app</h1>
<strong><nav>
<ul class="menu">
<li><a href="{{ url_for('home') }}">Home</a></li>
<li><a href="{{ url_for('about') }}">About</a></li>
</ul>
</nav></strong>
</div>
</header>
</body>
</html>
```

Let’s quickly see how this looks like by double clickling over the *layout.html* file. You should see this page:


file:///D:/Dropbox/Blogs/pythonflasktutorial/app/templates/layout.html

Ardit's web app

- Home
- About

If you’re now thinking you have to render the `layout.html` page in our Python function, you are wrong.

We keep the Python code as it is and modify the `home.html`, `about.html` and the `layout.html` files. The idea is to link `about.html` and `home.html` to `layout.html`. This would be done by adding a few lines of code in those files as you see below. Let’s start with `layout.html:`

```
<!DOCTYPE html>
<html>
<body>
<header>
<div class="container">
<h1 class="logo">Ardit's web app</h1>
<strong><nav>
```

```
<ul class="menu">
<li><a href="{{ url_for('home') }}">Home</a></li>
<li><a href="{{ url_for('about') }}">About</a></li>
</ul>
</nav></strong>
</div>
</header>
<div class="container">
{% block content %}
{% endblock %}
</div>
</body>
</html>
```

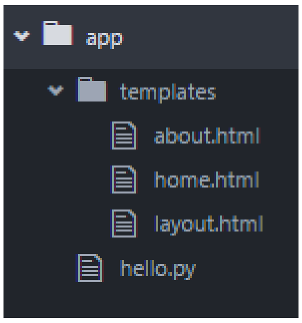
As you see from the highlighted lines, we added a new *div* section to the `layout.html` file. The two lines with curly brackets will be replaced on demand by either the `home.html`, or the `about.html` code depending on which URL the user is browsing. For that to happen, you also need to edit those two pages so that they connect to the `layout.html` page. Here is how the updated code looks like for home.html:

```
{% extends "layout.html" %}
{% block content %}
<div class="home">
<h1>A Python product</h1>
<p>This website was built with Python via the Flask framework.</p>
</div>
{% endblock %}
```

The same goes for about.html

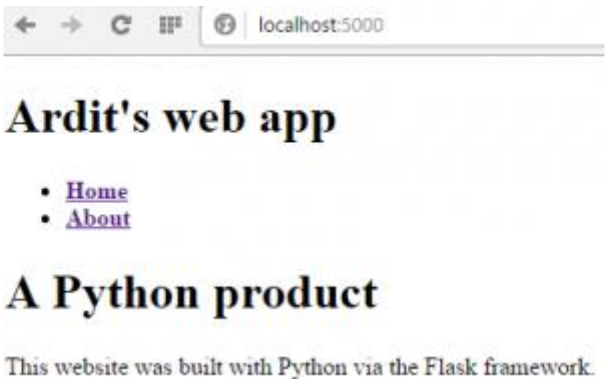
```
{% extends "layout.html" %}
{% block content %}
<div class="about">
<h1>About me</h1>
<p>This is a portfolio site about anything that can be put in a portfolio.</p>
</div>
{% endblock %}
```

And here is how the directory tree should look like:



```
app
  templates
    about.html
    home.html
    layout.html
  hello.py
```

Your website should now look as in the following screenshot and you should be able to load the webpages by clicking on the corresponding menu items:



Ardit's web app

- Home
- About

A Python product

This website was built with Python via the Flask framework.

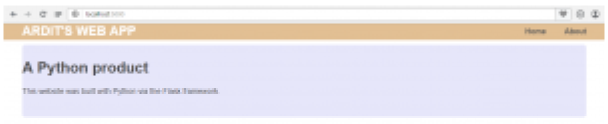
Great!

We have functional website!.

But…

We’re missing the flesh.

So, let’s add some CSS styling in the next lesson to make the site look like this:



A Python product

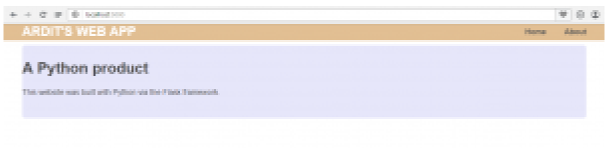
This website was built with Python via the Flask framework.

Adding CSS styling to your website

So far, our website consists of a Python script, and three HTML documents. The Python script handles the communication between the web server and the web client (i.e. browser) while the HTML documents are responsible for the structure of the page content.

Now we need to add some style formatting to the HTML structure using CSS (Cascading Style Sheets). That is done by creating a CSS file and connecting it to our HTML files. CSS is a style language that likewise HTML it is also very easy to learn. Python is much harder to learn than CSS,. So a rule of thumb is if you know Python, learning CSS should be a breeze.

At the end of this lesson, your website will look like this:

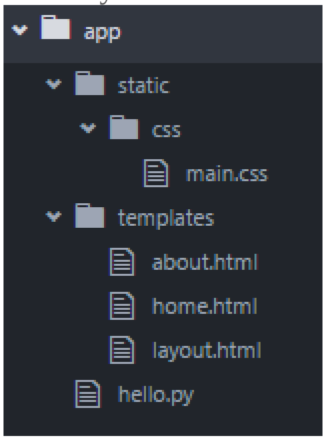


A Python product

This website was built with Python via the Flask framework.

Remember that HTML template files HTML go inside the *templates* folder. CSS stylesheets are considered static files. There is no interaction with their code, like there is with HTML templates. Therefore, flask has reserved a separate folder where you should put static files such as CSS, Javascript, images or other files. That folder should be created by you and should be named `static`.

So, let’s create an empty file inside the static folder and name it something like `main.css`. The directory tree should look like this now:


```
app
  static
    css
      main.css
  templates
    about.html
    home.html
    layout.html
  hello.py
```

Then, put this code inside the CSS file:

```
body {
margin: 0;
padding: 0;
font-family: "Helvetica Neue", Helvetica, Arial, sans-serif;
color: #444;
}

/*
* Formatting the header area
*/

header {
background-color: #DFB887;
height: 35px;
width: 100%;
opacity: .9;
margin-bottom: 10px;
}

header h1.logo {
margin: 0;
font-size: 1.7em;
color: #fff;
text-transform: uppercase;
float: left;
}

header h1.logo:hover {
color: #fff;
text-decoration: none;
}

/*
* Centering the body content
*/

.container {
width: 1200px;
margin: 0 auto;
}

div.home {
padding: 10px 0 30px 0;
background-color: #E6E6FA;
-webkit-border-radius: 6px;
-moz-border-radius: 6px;
border-radius: 6px;
}

div.about {
padding: 10px 0 30px 0;
background-color: #E6E6FA;
-webkit-border-radius: 6px;
-moz-border-radius: 6px;
border-radius: 6px;
}

h2 {
font-size: 3em;
margin-top: 40px;
text-align: center;
letter-spacing: -2px;
}

h3 {
font-size: 1.7em;
font-weight: 100;
margin-top: 30px;
text-align: center;
letter-spacing: -1px;
color: #999;
}

.menu {
float: right;
margin-top: 8px;
}
```

```
.menu li {
display: inline;
}

.menu li + li {
margin-left: 35px;
}

.menu li a {
color: #444;
text-decoration: none;
}
```

I assume the CSS file is quite self-explanatory. What the code is basically doing is referring to the HTML tags and div class names and applying fonts, colors, text size, padding, margins and background colors to those HTML elements.

Alright, we have a CSS file, but our HTML documents still don’t know how to link to it. The idea is we should link each page to the CSS, but because our `layout.html` code is at every page, we can insert the linking code to that. So, open your `layout.html` page and add a *head* section so that the code looks like this:

```
<!DOCTYPE html>
<html>
<head>
<title>Flask app</title>
<link rel="stylesheet" href="{{ url_for('static', filename='css/main.css') }}">
</head>
<body>
<header>
<div class="container">
<h1 class="logo">Ardit's web app</h1>
<strong><nav>
<ul class="menu">
<li><a href="{{ url_for('home') }}">Home</a></li>
<li><a href="{{ url_for('about') }}">About</a></li>
</ul>
</nav></strong>
</div>
</header>
<div class="container">
{% block content %}
{% endblock %}
</div>
```

```
</body>
</html>
```

As you see, we added a *title* and *link* tags to inside *head* tags. Inside the link tag we declared we are relating to a*stylesheet* document and then we specified the path to that style sheet.

Navigating to `localhost:5000` now should display the website you saw in the screenshot further above.

You can now add more content to it and tweak the HTML files by adding more divs if you want more sections in your webpages.

But, what does a website serve for if it's vegetating in your localhost?

It's completely useless if no one sees it.

No worries though, we will fix that right away by deploying the website in the Heroku cloud so that anyone can visit it through a public URL.

Let's move on to the next lesson.

Using virtualenv with your flask app

Your website is ready to deploy to an online server or to the cloud if you want to talk more futuristic.

However, deploying a flask application that has been built with your main Python installation can be a bad idea sometimes. Furthermore, it is not advisable to even start creating a web app using your main Python installation. Because you use Python for many other things, there can be a lot going in that installation.

Therefore, it would be good to have a clean environment that does not have to do with your main Python installation. The hero here is the *virtualenv* library. *virtualenv* is a Python library that creates a virtual environment with an isolated Python installation. That installation will serve only to our flask web application, and not any other purposes. That will allow us to deploy a clean application to the online server.

Creating a virtual environment is the first thing you should do before writing any code. In this tutorial I didn't want to confuse you with that and I decided to keep things plain and simple so that you could focus on the application instead. Now, you're mature enough to use a virtual environment for you web applications. So, next time you build a flask application, you should create a virtual environment before you write any file. And below you will learn how to create one.

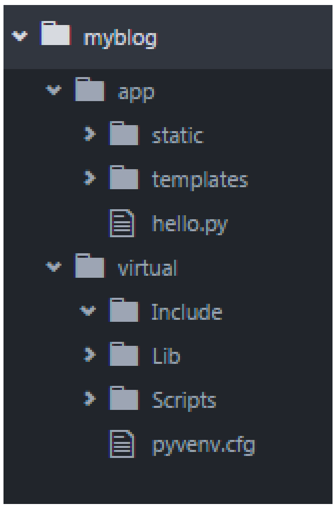
To create a virtual environment for Python, you should first install the *virtualenv* Python library for your current Python installation. That is the tool that will create a virtual environment in our local computer. To install *virtualenv*, type this in the terminal/command line.

```
pip install virtualenv
```

Once *virtualenv* is installed, you can then create a virtual environment. The virtual environment files should be generated inside a folder that is at the same directory level with the folder where your app files are. It's a good idea to create another folder (e.g. *myblog*) and put the *app* folder inside it. Then, open a terminal/command line while you in the *myblog* folder and type this:

```
python -m venv virtual
```

So, we're using Python and the `venv` library to create a folder named *virtual* with all the necessary virtual environment files. Your directory tree should look like this now.



If you explore the *Scripts* folder you will find a *python.exe* file. That means you have a Python installation in your virtual environment. And there is also a *pip.exe* which means you have the *pip* library with you as well and you can use it to install other libraries for your isolated Python.

And of course, we need to install our *flask* library if we want to run our website using the Python installation of our virtual environment. For that you need to use your isolated *pip*. So, while you are inside the main *myblog* folder, you can type this in the command line:

```
virtual\Scripts\pip install flask
```

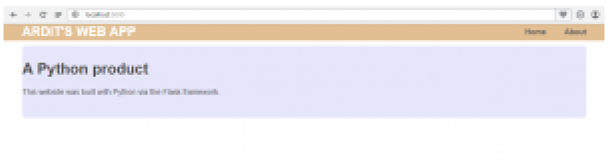
That should install flask under *virtual\Lib\site-packages*

Great!

Let's now run our website using our virtual environment. For that, while you are in the *myblog* folder, you need to point to the isolated Python and then to the `hello.py` script:

```
virtual\Scripts\python app\hello.py
```

That will show the same website on `localhost:5000` as it did before:



A Python product

This website was built with Python via the Flask framework.

Now we are ready to throw this beautiful website to the online cloud.

Deploying your Python web application to the Heroku cloud

In this part of the tutorial, you will deploy your flask web application. The process of deployment consists of transferring all your website files from your computer to the web server. Once you do that, your website can be visited by anyone through a public URL.

We will be using Heroku which is a cloud platform that supports Python web applications built with various programming languages including applications built with Python flask. Heroku makes things easier by handling administrative tasks by itself so that you can focus on the programming part. Another good thing is that you can host your web applications for free. As you get more traffic later, you may want to sign up for one of the better plans so that your web application performs well in high traffic. You can also have your own free subdomain on top of *herokuapp.com* or use your own domain if you have purchased one. I will use the domain *pythonflasktutorial.herokuapp.com* for the website that I built throughout this tutorial.

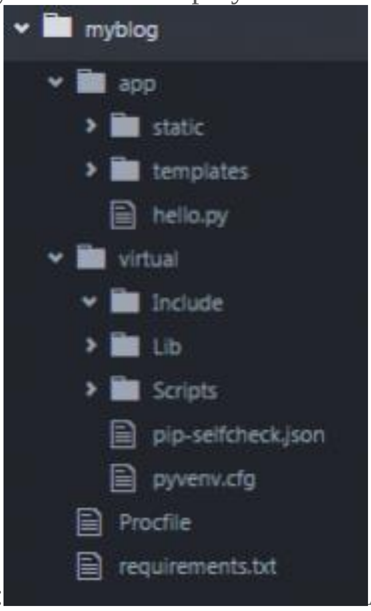
So, let's go and publish our website online. Here are the steps:

1. We will be using the *git* tool to send our local files to the online webserver or cloud if you like. So, the first thing to do is to download git from https://git-scm.com/downloads and install it. The process should be self explanatory.
2. Sign up for a free account on Heroku: heroku.com.
3. Download and install Heroku Toolbelt from https://toolbelt.heroku.com/.
   Heroku Toolbelt is a package that allows you to interact with the Heroku cloud through your computer command line and it needs *git* to do that. You already installed *git* in step 1.
4. Start interacting with your Heroku account through the command line. Open your command line while you are inside the*myblog* folder and type:
   ```
   heroku login
   ```
   Enter your heroku account credentials when asked about them.

5. Heroku doesn't have a webserver. Instead, it expects the application to use its own webserver. A Python webserver to be used is *gunicorn*.
   Gunicorn comes as a Python library, so you need to install it with *pip*. For that, in the

command line, type:
`virtual\Scripts\pip install gunicorn`

6. Create an empty file named *Procfile* in your current folder.
   Then enter this line inside the empty file: `web: gunicorn app.hello:app` The file shouldn't have any extension, so make sure the file name is not getting a *.txt* extension.

7. Create a *requirements.txt* file by typing:
   `virtual\Scripts\pip freeze > requirements.txt`
   That will generate a list of the Python libraries that are installed in your virtual environment and write the list inside the*requirements.txt* file. That file will then be sent and read by the webserver so that the webserver knows what libraries to install so that application runs correctly.
8. Great! Now, Heroku may run Python 2 by default for the applications that are sent to it. Therefore, it would be a good idea to declare what Python version your app has been designed to work with. I built my app using Python 3.5.1. To do that, you need to create a runtime.txt file and insert the this line in there: `python-3.5.1`
   That will tell Heroku what Python to use when running your app.
   With the two files (*requirements.txt* and *Procfile*) you created, you have now prepared all your files for deployment. Your directory tree should look like this now:
   

```
myblog
  app
    static
    templates
    hello.py
  virtual
    Include
    Lib
    Scripts
    pip-selfcheck.json
    pyvenv.cfg
  Procfile
  requirements.txt
```

   :As you see, *Procfile* and *requirements.txt* are under *myblog.*
   The next steps consist of creating an empty app on heroku and sending our local files to that app. And we will be sending the files using *git*. Let's move on.
9. Before using the git commands to send our files to Heroku, you need to tell git who you are. To do that, type this in the command line:

```
git config --global user.email “you@example.com”
```

Press enter and then type:

```
git config --global user.name "Your Name"
```

Make sure to replace your email address and your name appropriately in those lines keeping the double quotes.

9. Create a local git repository by typing:

   ```
   git init
   ```

   Add all your local files to the online repository by typing:

   ```
   git add .
   ```

   Make sure to include the dot after *add*. The dot means you are adding the entire directory to the repository.

11. Commit your files with:

    ```
    git commit –m “First commit”
    ```

12. Create an empty Heroku app:

    ```
    heroku create pythonflasktutorial
    ```

    I chose *pythonflasktutorial* as the name for my app. Make sure you pick your own name. Once the command is executed successfully, you can see that your app has been created in your Heroku account under the *Personal Apps* menu.
13. And the final step! Let’s push our application to Heroku:

    ```
    git push heroku master
    ```

14. Lastly, make sure at least one instance of the app is running with:

    ```
    heroku ps:scale web=1
    ```

15. If the amazing happened and you got here with no errors, your website should be now live. Mine is at live *pythonflasktutorial.heroku.com*

Maintaining your Python web app

If you've come to this point, chances are you have a running website on Heroku. This is the last part of the tutorial that will make sure you know how to add content to your website on Heroku.

Let's suppose your web app is running and you come back the next day to add some more content to your website. What you basically need to do is first you need to edit your local Python, HTML, CSS or other files depending on what you want to change, and then apply the *git add*, *commit* and the *push* commands to upload those modified files to the Heroku cloud. Does that sound too simplified? Here is the step by step guide:

1. Edit your local files. For instance, let's change the heading of the about page from "About me" to "About us". For that you would want to modify the *about.html* file.
2. Once you're done with the changes, open the command line in the *myblog* directory which is where *requirement.txt,Procfile* and the git and the app folders are located.
3. Login to Heroku with `heroku login` and enter the email address and the password of your Heroku account.
4. Heroku knows which of your app you want to modify by looking at your current local directory. Add the files with `git add .`
5. Commit the changes with `git commit -m "Change the about page"`
6. Push the changes to your app with `git push heroku master`
7. You're done. Navigate to your URL. If you can't recall your URL, call it using `heroku open`