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Timothée Mazzucotelli Feb 1, 2018

Docker Compose with NginX, Django, Gunicorn and multiple Postgres databases

This post explains how to setup your Docker configuration for a web application based on the Django framework. I got a lot of inspiration from other tutorials and Docker examples: you can check these resources with the links at the bottom of the post. You can also directly check the repository that reflects this tutorial.

In this particular example, we will use Gunicorn, but it should be easy enough to replace it with an alternative Python WSGI HTTP server such as uwsgi. We will also make use of pipenv, with related Pipfile and Pipfile.lock, instead of plain pip and requirements.txt files.

Here is the plan:

ReadTheBlog

About

Mar 15, 2018
Django application as an authentication / authorization server for Shiny

Mar 9, 2018
How to install NVidia drivers on BunsenLabs/Debian 8 to setup dual screens

Feb 1, 2018
Docker Compose with NginX, Django, Gunicorn and multiple Postgres databases

- Overview: to get a better understanding of the whole thing
- Dockerfile: a simple Django application served by Gunicorn
- Pipenv: spice things up with Pipfile and Pipfile.lock
- Compose: add a container for NginX
- Compose: add containers for one or more Postgres databases
- Static files: collecting, storing and serving
- Resources

May 31, 2017
Python static code analysis tools

Dec 7, 2016
Documentation in your shell scripts using shellman

Dec 7, 2016
Write and use a tox plugin from inside your package

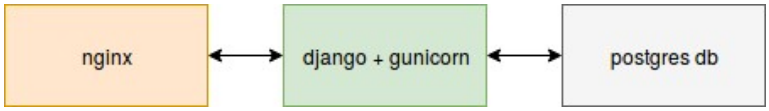
Apr 6, 2016
Django admin dashboard with Suit and Highcharts

6. Static files: collecting, storing and serving
7. Resources

Overview: to get a better understanding of the whole thing

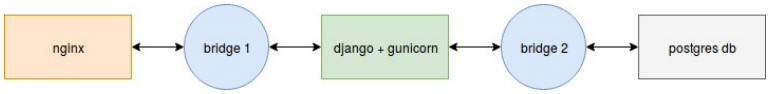
So, let's start with some drawings in order to get a better idea of what we want to accomplish, and how everything will fit together.

In this first, very simple image, you can see that we want three containers: one for NginX, one for Django + Gunicorn (they always go together), and one for our database. The NginX container communicate with the Django+Gunicorn one, which itself connects to the Postgres container. Pretty straight-forward, right?



In our configuration, it means we will declare three containers, or three services if we talk in terms of Docker Compose.

Except that we need bridges between the containers, in order for them to communicate. Let's add these bridges:



In `docker-compose.yml`, we will declare these bridges thanks to the `networks` directive, and connect them to the right containers.

Of course, you may want or need several databases for your project. So here is an updated image with two database containers. It's simply a matter of adding a new brige:

ReadTheBlog

About

Mar 15, 2018
Django application as an authentication / authorization server for Shiny

Mar 9, 2018
How to install NVidia drivers on BunsenLabs/Debian 8 to setup dual screens

Feb 1, 2018
Docker Compose with NginX, Django, Gunicorn and multiple Postgres databases

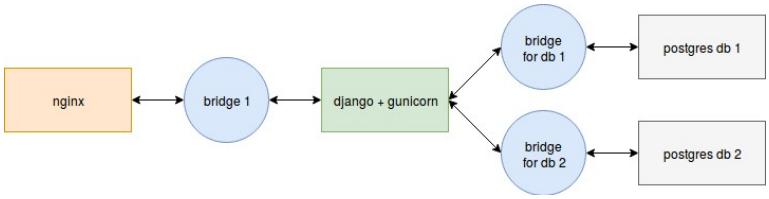
- Overview: to get a better understanding of the whole thing
- Dockerfile: a simple Django application served by Gunicorn
- Pipenv: spice things up with Pipfile and Pipfile.lock
- Compose: add a container for NginX
- Compose: add containers for one or more Postgres databases
- Static files: collecting, storing and serving
- Resources

May 31, 2017
Python static code analysis tools

Dec 7, 2016
Documentation in your shell scripts using shellman

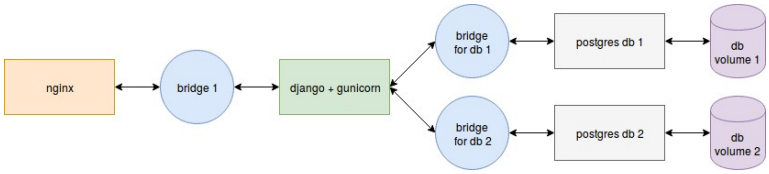
Dec 7, 2016
Write and use a tox plugin from inside your package

Apr 6, 2016
Django admin dashboard with Suit and Highcharts



Once you know how to do it for two databases, it's very easy to add more.

Now, this is enough for local development. But each time you restart your containers or services, the data in the Postgres databases will be lost. In production, we need these data to be persistent. If we keep the data in production, let's keep them in local environment as well. To do this, we will use volumes, a feature of Docker:



Alright, that is enough for the overview, let's get our hands dirty!

Dockerfile: a simple Django application served by Gunicorn

If you don't already have a simple Django project available for testing, I invite you to create one with `django-admin startproject hello`.

Here is the directory/file tree you should have in order to follow this tutorial:

```
.                           # Your current di
└── hello                   # The Django proje
    ├── hello               # The main Django
    │   ├── __init__.py
    │   ├── settings.py
    │   ├── urls.py
    │   └── wsgi.py
    └── manage.py
```

Now that you have a working Django project, you can run it by going into the `hello` directory and type `./manage.py runserver`. Go to http://localhost:8000 to see the result.

Instead of running it with the Django `runserver` management command, let's try with Gunicorn. First, install it with `pip install gunicorn`, be it in a virtualenv or system-wide with `sudo pip install gunicorn`.

It's as easy as running `gunicorn --bind :8000 hello.wsgi:application` from inside the Django project. If you are one directory above, use `gunicorn --chdir hello --bind :8000 hello.wsgi:application`.

We have all we need to write our Dockerfile:

```
# start from an official image
FROM python:3.6

# arbitrary location choice: you can change
RUN mkdir -p /opt/services/djangoapp/src
WORKDIR /opt/services/djangoapp/src

# install our two dependencies
RUN pip install gunicorn django

# copy our project code
COPY . /opt/services/djangoapp/src

# expose the port 8000
EXPOSE 8000

# define the default command to run when sta
CMD ["gunicorn", "--chdir", "hello", "--binc
```

The Dockerfile must be placed at the root of your test directory. As a reminder:

```
.                           # Your current di
├── hello                   # The Django proje
│   ├── hello               # The main Django
```

ReadTheBlog

About

Mar 15, 2018
Django application as an authentication / authorization server for Shiny

Mar 9, 2018
How to install NVidia drivers on BunsenLabs/Debian 8 to setup dual screens

Feb 1, 2018
Docker Compose with NginX, Django, Gunicorn and multiple Postgres databases

- Overview: to get a better understanding of the whole thing
- Dockerfile: a simple Django application served by Gunicorn
- Pipenv: spice things up with Pipfile and Pipfile.lock
- Compose: add a container for NginX
- Compose: add containers for one or more Postgres databases
- Static files: collecting, storing and serving
- Resources

May 31, 2017
Python static code analysis tools

Dec 7, 2016
Documentation in your shell scripts using shellman

Dec 7, 2016
Write and use a tox plugin from inside your package

Apr 6, 2016
Django admin dashboard with Suit and Highcharts

```
│   └── manage.py
└── Dockerfile              # Your Dockerfile
```

We are now able to build our container with `docker build . -t hello`, and to start it with `docker run -p 8000:8000 hello`. The `-p 8000:8000` option says to bind the port 8000 of the host to the port 8000 of the container, allowing you to go to http://localhost:8000 and see your application running as if you were inside of the container.

Pipenv: spice things up with Pipfile and Pipfile.lock

This step is completely optional. If you prefer to use plain pip and requirements files, you can skip this section.

First install pipenv with `pip install pipenv`, or system-wide with `sudo pip install pipenv`. Since we only need Django and Gunicorn, our Pipfile will be very simple:

```
[[source]]
url = "https://pypi.python.org/simple"
verify_ssl = true
name = "pypi"


[packages]
Django = "*"
gunicorn = "*"


[requires]
# our Dockerfile is based on Python 3.6
python_version = "3.6"
```

Just like the Dockerfile, Pipfile must be placed at the root of the project.

```
.
├── hello
```

```
│   ├── hello
│   └── manage.py
├── Dockerfile
└── Pipfile
```

Simply run `pipenv lock` to create Pipfile.lock from Pipfile.

Now we need to update our Dockerfile to use pipenv:

```
# start from an official image
FROM python:3.6

# arbitrary location choice: you can change
RUN mkdir -p /opt/services/djangoapp/src
WORKDIR /opt/services/djangoapp/src

# install our dependencies
# we use --system flag because we don't nee
COPY Pipfile Pipfile.lock /opt/services/dja
RUN pip install pipenv && pipenv install --

# copy our project code
COPY . /opt/services/djangoapp/src

# expose the port 8000
EXPOSE 8000

# define the default command to run when sta
CMD ["gunicorn", "--chdir", "hello", "--bin
```

You can rebuild the image with `docker build . -t hello` and try to run it again to see if everything works correctly.

Compose: add a container for NginX

Since we will then have two containers, one for Django + Gunicorn, and one for NginX, it's time to start our composition with Docker Compose and `docker-compose.yml`. Create your `docker-compose.yml` file

ReadTheBlog

About

Mar 15, 2018
Django application as an authentication / authorization server for Shiny

Mar 9, 2018
How to install NVidia drivers on BunsenLabs/Debian 8 to setup dual screens

Feb 1, 2018
Docker Compose with NginX, Django, Gunicorn and multiple Postgres databases

- Overview: to get a better understanding of the whole thing
- Dockerfile: a simple Django application served by Gunicorn
- Pipenv: spice things up with Pipfile and Pipfile.lock
- Compose: add a container for NginX
- Compose: add containers for one or more Postgres databases
- Static files: collecting, storing and serving
- Resources

May 31, 2017
Python static code analysis tools

Dec 7, 2016
Documentation in your shell scripts using shellman

Dec 7, 2016
Write and use a tox plugin from inside your package

Apr 6, 2016
Django admin dashboard with Suit and Highcharts

at the root of the project, like following:

```
.
├── hello
│   ├── hello
│   └── manage.py
├── docker-compose.yml
├── Dockerfile
└── Pipfile
```

We are gonna use the version 3 of the configuration syntax. First, we add the Django+Gunicorn service:

```
version: '3'

services:
  djangoapp:
    build: .
    volumes:
      - .:/opt/services/djangoapp/src
    ports:
      - 8000:8000
```

We simply tell Docker Compose that the `djangoapp` service must use an image that is built from the current directory, therefore looking for our Dockerfile. The `volumes` directive tells to bind the current directory of the host to the `/opt/services/djangoapp/src` directory of the container. The changes in our current directory will be reflected in real-time in the container directory. And reciprocally, changes that occur in the container directory will occur in our current directory as well.

Build and run the service with `docker-compose up`. The name of the image will be automatically chosen by Docker Compose (it will be the name of the current directory with `_djangoapp` appended).

Ok, let's add our NginX service now:

```
version: '3'
```

ReadTheBlog

About

Mar 15, 2018
Django application as an authentication / authorization server for Shiny

Mar 9, 2018
How to install NVidia drivers on BunsenLabs/Debian 8 to setup dual screens

Feb 1, 2018
Docker Compose with NginX, Django, Gunicorn and multiple Postgres databases

- Overview: to get a better understanding of the whole thing
- Dockerfile: a simple Django application served by Gunicorn
- Pipenv: spice things up with Pipfile and Pipfile.lock
- Compose: add a container for NginX
- Compose: add containers for one or more Postgres databases
- Static files: collecting, storing and serving
- Resources

May 31, 2017
Python static code analysis tools

Dec 7, 2016
Documentation in your shell scripts using shellman

Dec 7, 2016
Write and use a tox plugin from inside your package

Apr 6, 2016
Django admin dashboard with Suit and Highcharts

```
services:

  djangoapp:
    build: .
    volumes:
      - .:/opt/services/djangoapp/src

  nginx:
    image: nginx:1.13
    ports:
      - 8000:80
    volumes:
      - ./config/nginx/conf.d:/etc/nginx/co
    depends_on:  # <-- wait for djangoapp t
      - djangoapp
```

Note that we removed the `ports` directive from our `djangoapp` service. Indeed we will not communicate directly with Gunicorn anymore, but with NginX. We still want to access our app at http://localhost:8000, and we want NginX to listen to the port 80 in the container, so we use `ports: - 8000:80`.

Note: in a production environment, we would use `80:80` instead.

We also bind a local directory to the `/etc/nginx/conf.d` container directory. Let's create it and see what's inside:

```
mkdir -p config/nginx/conf.d
touch config/nginx/conf.d/local.conf
```

You should now have the following files and directories:

```
.
├── config
│   └── nginx
│       └── conf.d
│           └── local.conf
├── docker-compose.yml
├── Dockerfile
├── hello
│   ├── hello
```

ReadTheBlog

About

Mar 15, 2018
Django application as an authentication / authorization server for Shiny

Mar 9, 2018
How to install NVidia drivers on BunsenLabs/Debian 8 to setup dual screens

Feb 1, 2018
Docker Compose with NginX, Django, Gunicorn and multiple Postgres databases

- Overview: to get a better understanding of the whole thing
- Dockerfile: a simple Django application served by Gunicorn
- Pipenv: spice things up with Pipfile and Pipfile.lock
- Compose: add a container for NginX
- Compose: add containers for one or more Postgres databases
- Static files: collecting, storing and serving
- Resources

May 31, 2017
Python static code analysis tools

Dec 7, 2016
Documentation in your shell scripts using shellman

Dec 7, 2016
Write and use a tox plugin from inside your package

Apr 6, 2016
Django admin dashboard with Suit and Highcharts

```
│   └── manage.py
├── Pipfile
└── Pipfile.lock
```

The `config/nginx/conf.d/local.conf` file contains our NginX configuration:

```
# first we declare our upstream server, whi
upstream hello_server {
    # docker will automatically resolve thi
    # because we use the same name as the se
    server djangoapp:8000;
}

# now we declare our main server
server {

    listen 80;
    server_name localhost;

    location / {
        # everything is passed to Gunicorn
        proxy_pass http://hello_server;
        proxy_set_header X-Forwarded-For $pr
        proxy_set_header Host $host;
        proxy_redirect off;
    }
}
```

But before we try this out, remember that we need a bridge to make our services able to communicate?

Update your `docker-compose.yml` as follow:

```
version: '3'

services:

  djangoapp:
    build: .
    volumes:
      - .:/opt/services/djangoapp/src
    networks:  # <-- here
      - nginx_network
```

```
  nginx:
    image: nginx:1.13
    ports:
      - 8000:80
    volumes:
      - ./config/nginx/conf.d:/etc/nginx/co
    depends_on:
      - djangoapp
    networks:  # <-- here
      - nginx_network

networks:  # <-- and here
  nginx_network:
    driver: bridge
```

Run `docker-compose up` and see if you can still see the Django default page at http://localhost:8000.

Compose: add containers for one or more Postgres databases

We now want to use Postgres instead of the starting default SQLite database. We will need to update several things: our Pipfile, because we need the `psycopg2` Python package, the Postgres driver; our Django project settings; and our `docker-compose.yml` file.

- Pipfile becomes:

```
[[source]]
url = "https://pypi.python.org/simple"
verify_ssl = true
name = "pypi"


[packages]
Django = "*"
gunicorn = "*"
"psycopg2" = "*"
```

ReadTheBlog

About

Mar 15, 2018
Django application as an authentication / authorization server for Shiny

Mar 9, 2018
How to install NVidia drivers on BunsenLabs/Debian 8 to setup dual screens

Feb 1, 2018
Docker Compose with NginX, Django, Gunicorn and multiple Postgres databases

- Overview: to get a better understanding of the whole thing
- Dockerfile: a simple Django application served by Gunicorn
- Pipenv: spice things up with Pipfile and Pipfile.lock
- Compose: add a container for NginX
- Compose: add containers for one or more Postgres databases
- Static files: collecting, storing and serving
- Resources

May 31, 2017
Python static code analysis tools

Dec 7, 2016
Documentation in your shell scripts using shellman

Dec 7, 2016
Write and use a tox plugin from inside your package

Apr 6, 2016
Django admin dashboard with Suit and Highcharts

```
[requires]
# our Dockerfile is based on Python 3.6
python_version = "3.6"
```

Don't forget to run `pipenv lock` to update your lock file, and rebuild your Docker image with `docker-compose build`.

- In the Django project settings, update the DATABASE setting from:

```
DATABASES = {
    'default': {
        'ENGINE': 'django.db.backends.sq
        'NAME': os.path.join(BASE_DIR, '
    }
}
```

…to:

```
DATABASES = {
    'default': {
        'ENGINE': 'django.db.backends.po
        'NAME': 'database1',
        'USER': 'database1_role',
        'PASSWORD': 'database1_password'
        'HOST': 'database1',  # <-- IMPO
        'PORT': '5432',
    }
}
```

As you can see, we used `database1` everywhere, for the name, user, password and host. In fact, we can change these values to whatever suits us. But we must ensure the database container will use the same values! To do that, we will copy these values in a configuration file destined to be read by our database container.

Create a `db` directory in the `config` one, and add the `database1_env` file:

ReadTheBlog

About

Mar 15, 2018
Django application as an authentication / authorization server for Shiny

Mar 9, 2018
How to install NVidia drivers on BunsenLabs/Debian 8 to setup dual screens

Feb 1, 2018
Docker Compose with NginX, Django, Gunicorn and multiple Postgres databases

- Overview: to get a better understanding of the whole thing
- Dockerfile: a simple Django application served by Gunicorn
- Pipenv: spice things up with Pipfile and Pipfile.lock
- Compose: add a container for NginX
- Compose: add containers for one or more Postgres databases
- Static files: collecting, storing and serving
- Resources

May 31, 2017
Python static code analysis tools

Dec 7, 2016
Documentation in your shell scripts using shellman

Dec 7, 2016
Write and use a tox plugin from inside your package

Apr 6, 2016
Django admin dashboard with Suit and Highcharts

```
mkdir config/db
touch config/db/database1_env
```

The contents of `config/db/database1_env` must then be:

```
POSTGRES_USER=database1_role
POSTGRES_PASSWORD=database1_password
POSTGRES_DB=database1
```

These variable are used by the Postgres Docker image, for more information please check out the documentation on docs.docker.com or hub.docker.com.

It means that, when started, the Postgres container will create a database called `database1`, assigned to the role `database1_role` with password `database1_password`. If you change these values, remember to also change them in the DATABASES setting.

- We are now ready to add our service in `docker-compose.yml`. **The added service must have the same name than what is declared in the DATABASES setting:**

```
version: '3'

services:

  djangoapp:
    build: .
    volumes:
      - .:/opt/services/djangoapp/src
    networks:
      - nginx_network
      - database1_network  # <-- connect
    depends_on:  # <-- wait for db to be
      - database1

  nginx:
    image: nginx:1.13
```

ReadTheBlog

About

Mar 15, 2018
Django application as an authentication / authorization server for Shiny

Mar 9, 2018
How to install NVidia drivers on BunsenLabs/Debian 8 to setup dual screens

Feb 1, 2018
Docker Compose with NginX, Django, Gunicorn and multiple Postgres databases

- Overview: to get a better understanding of the whole thing
- Dockerfile: a simple Django application served by Gunicorn
- Pipenv: spice things up with Pipfile and Pipfile.lock
- Compose: add a container for NginX
- Compose: add containers for one or more Postgres databases
- Static files: collecting, storing and serving
- Resources

May 31, 2017
Python static code analysis tools

Dec 7, 2016
Documentation in your shell scripts using shellman

Dec 7, 2016
Write and use a tox plugin from inside your package

Apr 6, 2016
Django admin dashboard with Suit and Highcharts

```
    ports:
      - 8000:80
    volumes:
      - ./config/nginx/conf.d:/etc/nginx
    depends_on:
      - djangoapp
    networks:
      - nginx_network

  database1:  # <-- IMPORTANT: same name
    image: postgres:10
    env_file:  # <-- we use the previous
      - config/db/database1_env
    networks:  # <-- connect to the brid
      - database1_network
    volumes:
      - database1_volume:/var/lib/postgr

networks:
  nginx_network:
    driver: bridge
  database1_network:  # <-- add the brid
    driver: bridge

volumes:
  database1_volume:
```

You should be able to understand everything here. However, we added two new things: the `database1: volumes:` directive, and the root `volumes:` directive. You need to declare your volumes in the root `volumes:` directive if you want them to be kept persistently. Then, you can bind a volume to a directory in the container. Here, we bind our declared `database1_volume` to the `database1` container's `/var/lib/postgresql/data` directory. Everything added to this directory will be persistently stored in the volume called `database1_volume`. So each subsequent run of the container will have access to the previous data! It means you can stop and restart your service without losing the data.

OK, let's try it. As we are using Django, we need to

ReadTheBlog

About

Mar 15, 2018
Django application as an authentication / authorization server for Shiny

Mar 9, 2018
How to install NVidia drivers on BunsenLabs/Debian 8 to setup dual screens

Feb 1, 2018
Docker Compose with NginX, Django, Gunicorn and multiple Postgres databases

- Overview: to get a better understanding of the whole thing
- Dockerfile: a simple Django application served by Gunicorn
- Pipenv: spice things up with Pipfile and Pipfile.lock
- Compose: add a container for NginX
- Compose: add containers for one or more Postgres databases
- Static files: collecting, storing and serving
- Resources

May 31, 2017
Python static code analysis tools

Dec 7, 2016
Documentation in your shell scripts using shellman

Dec 7, 2016
Write and use a tox plugin from inside your package

Apr 6, 2016
Django admin dashboard with Suit and Highcharts

"migrate" the database first. To do this, we will simply use Docker Compose to start our `djangoapp` service and run the migration command inside it:

```
docker-compose build  # to make sure everyti
docker-compose run --rm djangoapp /bin/bash
```

From now on, it should be really easy to add other databases: just add other database services (`database2`) with their networks volumes (remember to connect the networks and bind the volumes), update your DATABASES setting in the Django project, and create the environment file for each database in `config/db`.

Static files: collecting, storing and serving

Let's not forget about the static files! In order for NginX to serve them, we will update the `config/nginx/conf.d/local.conf` file, as well as our Dockerfile and `docker-compose.yml` file. Static files will be stored in volumes. We also need to set the STATIC_ROOT variable in the Django project settings.

- NginX configuration:

```
upstream hello_server {
    server djangoapp:8000;
}

server {

    listen 80;
    server_name localhost;

    location / {
        proxy_pass http://hello_server;
        proxy_set_header X-Forwarded-For
        proxy_set_header Host $host;
        proxy_redirect off;
    }
```

ReadTheBlog

About

Mar 15, 2018
Django application as an authentication / authorization server for Shiny

Mar 9, 2018
How to install NVidia drivers on BunsenLabs/Debian 8 to setup dual screens

Feb 1, 2018
Docker Compose with NginX, Django, Gunicorn and multiple Postgres databases

- Overview: to get a better understanding of the whole thing
- Dockerfile: a simple Django application served by Gunicorn
- Pipenv: spice things up with Pipfile and Pipfile.lock
- Compose: add a container for NginX
- Compose: add containers for one or more Postgres databases
- Static files: collecting, storing and serving
- Resources

May 31, 2017
Python static code analysis tools

Dec 7, 2016
Documentation in your shell scripts using shellman

Dec 7, 2016
Write and use a tox plugin from inside your package

Apr 6, 2016
Django admin dashboard with Suit and Highcharts

```
    location /static/ {
        alias /opt/services/djangoapp/st
    }

    location /media/ {
        alias /opt/services/djangoapp/me
    }
}
```

- Django project settings:

```
# as declared in NginX conf, it must mat
STATIC_ROOT = os.path.join(os.path.dirna

# do the same for media files, it must m
MEDIA_ROOT = os.path.join(os.path.dirnam
```

- Collect the static files in the Dockerfile:

```
FROM python:3.6

RUN mkdir -p /opt/services/djangoapp/src
WORKDIR /opt/services/djangoapp/src

COPY Pipfile Pipfile.lock /opt/services/
RUN pip install pipenv && pipenv install

COPY . /opt/services/djangoapp/src
RUN cd hello && python manage.py collect

EXPOSE 8000
CMD ["gunicorn", "--chdir", "hello", "--
```

- Volumes in `docker-compose.yml`:

```
version: '3'

services:

  djangoapp:
    build: .
    volumes:
      - .:/opt/services/djangoapp/src
```

ReadTheBlog

About

Mar 15, 2018
Django application as an authentication / authorization server for Shiny

Mar 9, 2018
How to install NVidia drivers on BunsenLabs/Debian 8 to setup dual screens

Feb 1, 2018
Docker Compose with NginX, Django, Gunicorn and multiple Postgres databases

- Overview: to get a better understanding of the whole thing
- Dockerfile: a simple Django application served by Gunicorn
- Pipenv: spice things up with Pipfile and Pipfile.lock
- Compose: add a container for NginX
- Compose: add containers for one or more Postgres databases
- Static files: collecting, storing and serving
- Resources

May 31, 2017
Python static code analysis tools

Dec 7, 2016
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```
      - static_volume:/opt/services/djan
      - media_volume:/opt/services/djang
    networks:
      - nginx_network
      - database1_network
    depends_on:
      - database1

  nginx:
    image: nginx:1.13
    ports:
      - 8000:80
    volumes:
      - ./config/nginx/conf.d:/etc/nginx
      - static_volume:/opt/services/djan
      - media_volume:/opt/services/djang
    depends_on:
      - djangoapp
    networks:
      - nginx_network

  database1:
    image: postgres:10
    env_file:
      - config/db/database1_env
    networks:
      - database1_network
    volumes:
      - database1_volume:/var/lib/postgr

networks:
  nginx_network:
    driver: bridge
  database1_network:
    driver: bridge

volumes:
  database1_volume:
  static_volume:  # <-- declare the stat
  media_volume:  # <-- declare the media
```

Now rebuild: `docker-compose build` and run: `docker-compose up` !

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About

Mar 15, 2018
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How to install NVidia drivers on BunsenLabs/Debian 8 to setup dual screens

Feb 1, 2018
Docker Compose with NginX, Django, Gunicorn and multiple Postgres databases

Overview: to get a better understanding of the whole thing

Dockerfile: a simple Django application served by Gunicorn

Pipenv: spice things up with Pipfile and Pipfile.lock

Compose: add a container for NginX

Compose: add containers for one or more Postgres databases

Static files: collecting, storing and serving

Resources

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Resources

Here are the resources I used to write this tutorial:

- Nginx+Flask+Postgres multi-container setup with Docker Compose
  - The repository
- Docker how to Django + uwsgi/gunicorn + nginx?
- Django tutorial using Docker, Nginx, Gunicorn and PostgreSQL.
- Django Development With Docker Compose and Machine
- Deploy Django, Gunicorn, NGINX, Postgresql using Docker
- Docker, how to expose a socket over a port for a Django Application

And here is the repository that reflects this tutorial (with a few more things).

Don’t hesitate to share other interesting resources in the comment section!

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Findings, thoughts, tutorials, work. Pieces of my mind!

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