

Lab 5: Composing Environments with Docker Compose

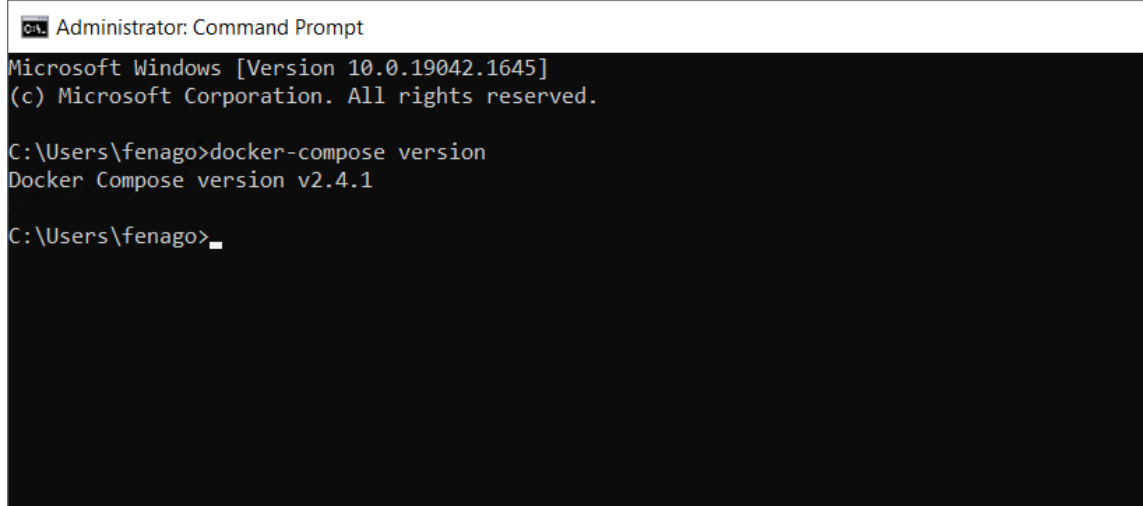
This lab covers the creation and management of multi-container applications using Docker Compose. You will learn how to create Docker Compose files to define complex containerized applications and how to run the Docker Compose CLI to manage the life cycle of multi-container applications. This lab will enable you to configure Docker Compose applications with different methods and design applications with dependencies on other applications.

Docker Compose CLI

Test the CLI and installation with the following command in the terminal on all operating systems:

```
docker-compose version
```

If it is installed correctly, you will see the versions of the CLI as follows.



```
Administrator: Command Prompt
Microsoft Windows [Version 10.0.19042.1645]
(c) Microsoft Corporation. All rights reserved.

C:\Users\fenago>docker-compose version
Docker Compose version v2.4.1

C:\Users\fenago>
```

Docker Compose CLI Commands

The `docker-compose` command is capable of managing the complete life cycle of multi-containers applications. With the subcommands, it is possible to start, stop, and recreate services. Also, it is possible to check the status of the running stacks and get the logs. You will get hands-on experience with the essential commands throughout this lab. Likewise, a preview of all capabilities can be listed with the following command:

```
docker-compose --help
```

The output of the command should look like the following:

```
[ /docker-ws $ docker-compose --help
Define and run multi-container applications with Docker.

Usage:
  docker-compose [-f <arg>...] [options] [COMMAND] [ARGS...]
  docker-compose -h|--help

Options:
  -f, --file FILE            Specify an alternate compose file
                              (default: docker-compose.yml)
  -p, --project-name NAME    Specify an alternate project name
                              (default: directory name)
  ...

Commands:
  build                      Build or rebuild services
  bundle                    Generate a Docker bundle from the Compose file
  config                    Validate and view the Compose file
  create                    Create services
  down                      Stop and remove containers, networks, images, and volumes
  events                    Receive real time events from containers
  exec                      Execute a command in a running container
  help                      Get help on a command
  images                    List images
  kill                      Kill containers
  logs                      View output from containers
  pause                    Pause services
  port                      Print the public port for a port binding
  ps                        List containers
  pull                      Pull service images
  push                      Push service images
  restart                  Restart services
  rm                        Remove stopped containers
  run                       Run a one-off command
  scale                     Set number of containers for a service
  start                    Start services
  stop                     Stop services
  top                      Display the running processes
  unpause                  Unpause services
  up                       Create and start containers
  version                  Show the Docker-Compose version information
/docker-ws $ █
```

Exercise 5.01: Getting Started with Docker Compose

Web servers in containers require operational tasks before starting, such as configuration, file downloads, or dependency installations. With `docker-compose`, it is possible to define those operations as multi-container applications and run them with a single command. In this exercise, you will create a preparation container to generate static files, such as `index.html` files. Then, the server container will serve the static files, and it will be reachable from the host machine by the network configuration. You will also manage the life cycle of the application using various `docker-compose` commands.

To complete the exercise, execute the following steps:

1. Create a folder named `server-with-compose` and navigate into it using the `cd` command:

```
mkdir server-with-compose
cd server-with-compose
```

2. Create a folder with the name `init` and navigate into it using the `cd` command:

```
mkdir init
cd init
```

3. Create a Bash script file with the following content and save it as `prepare.sh`:

```
#!/usr/bin/env sh
rm /data/index.html
echo "<h1>Welcome from Docker Compose!</h1>" >> /data/index.html
echo "<img src='https://raw.githubusercontent.com/fenago/docker-course/master/md/logo.png' />" >> /data/index.html
```

This script generates a sample HTML page with the `echo` commands.

4. Create a `Dockerfile` with the name `Dockerfile` and the following content:

```
FROM busybox
ADD prepare.sh /usr/bin/prepare.sh
RUN chmod +x /usr/bin/prepare.sh
ENTRYPOINT ["sh", "/usr/bin/prepare.sh"]
```

This `Dockerfile` is based on `busybox`, which is a tiny operating system for space-efficient containers, and it adds the `prepare.sh` script into the filesystem. In addition, it makes the file executable and set it as the `ENTRYPOINT` command. The `ENTRYPOINT` command, in our case, the `prepare.sh` script is initialized with the start of the Docker container.

5. Change the directory to the parent folder with the `cd ..` command and create a `docker-compose.yml` file with the following content:

```
version: "3"
services:
  init:
    build:
      context: ./init
    volumes:
      - static:/data

  server:
    image: nginx
    volumes:
      - static:/usr/share/nginx/html
    ports:
      - "8080:80"
volumes:
  static:
```

This `docker-compose` file creates one volume named `static`, and two services with the names `init` and `server`. The volume is mounted to both containers. In addition, the server has published port `8080`, connecting to container port `80`.

6. Start the application with the following command in `detach` mode to continue using the Terminal:

```
docker-compose up --detach
```

The following image shows what happens when the preceding command is executed:

```
- c229119241af Pull complete 19.1s
- 2215908dc0a2 Pull complete 23.2s
- 08c3cb2073f1 Pull complete 23.7s
- 18f38162c0ce Pull complete 24.0s
- 10e2168f148a Pull complete 24.2s
- c4ffe9532b5f Pull complete 24.7s
[+] Building 5.0s (8/8) FINISHED
=> [internal] load build definition from Dockerfile 0.9s
=> => transferring dockerfile: 170B 0.1s
=> [internal] load .dockerignore 0.8s
=> => transferring context: 2B 0.0s
=> [internal] load metadata for docker.io/library/busybox:latest 0.0s
=> [1/3] FROM docker.io/library/busybox 0.1s
=> [internal] load build context 0.2s
=> => transferring context: 263B 0.0s
=> [2/3] ADD prepare.sh /usr/bin/prepare.sh 1.7s
=> [3/3] RUN chmod +x /usr/bin/prepare.sh 1.2s
=> exporting to image 0.3s
=> => exporting layers 0.3s
=> => writing image sha256:d12057e1ce84d1ca7c84e3b84360bee5853ef24150fa286c39e7b7b32899cfd0 0.0s
=> => naming to docker.io/library/exercise501_init 0.0s

Use 'docker scan' to run Snyk tests against images to find vulnerabilities and learn how to fix them
[+] Running 4/4
- Network exercise501_default Created 0.1s
- Volume "exercise501_static" Created 0.0s
- Container exercise501-init-1 Started 1.9s
- Container exercise501-server-1 Started 2.1s
```

The preceding command creates and starts the containers in `detached` mode. It starts by creating the `server-with-compose_default` network and the `server-with-compose_static` volume. Then, it builds the `init` container using the `Dockerfile` from *step 4*, downloads the `nginx` Docker image for the server, and starts the containers. Finally, it prints the names of the containers and makes them run in the background.

Note: You can disregard the warning about Swarm mode since we want to deploy all containers to the same node.

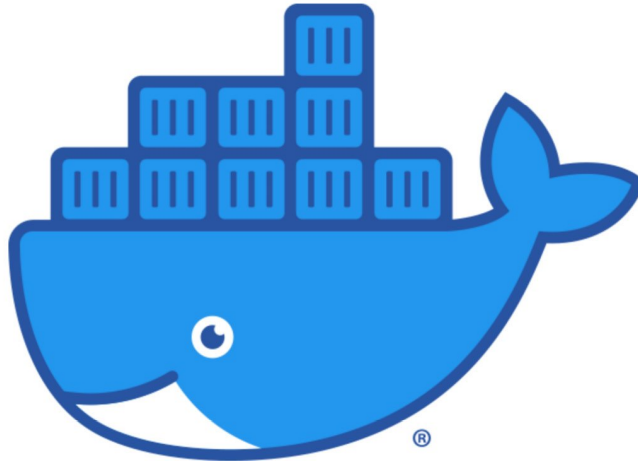
7. Check the status of the application with the `docker-compose ps` command:

```
C:\Users\fenago\Desktop\docker-course\lab05\Exercise5.01>docker-compose ps
NAME                COMMAND                                SERVICE    STATUS          PORTS
exercise501-init-1  "sh /usr/bin/prepare..."            init       exited (0)
exercise501-server-1 "/docker-entrypoint..."             server     running         0.0.0.0:8080->80/tcp
```

This output lists two containers. The `init` container exited successfully with code `0`, while the `server` container is `Up` and its port is available. This is the expected output since the `init` container is designed to prepare the `index.html` file and complete its operations, whereas the `server` container should always be up and running.

8. Open `http://localhost:8080` in the browser. The following figure shows the output:

Welcome from Docker Compose!



Above image shows the `index.html` page created by the `init` container. In other words, it shows that `docker-compose` created the volume, mounted it to the containers, and started them successfully.

9. Stop and remove all the resources with the following command if you do not need the application up and running:

```
docker-compose down
```

The command will return output like the following:

```
[ /docker-ws $ docker-compose down
Stopping server-with-compose_server_1 ... done
Removing server-with-compose_server_1 ... done
Removing server-with-compose_init_1    ... done
Removing network server-with-compose_default
/docker-ws $
```

In this exercise, a multi-container application was created and configured by `docker-compose`. Networking and volume options were stored in the `docker-compose.yml` file. In addition, CLI commands were shown in action for creating applications, checking the status, and removing the applications.

In the following section, configuration options for applications in the Docker Compose environment will be presented.

Exercise 5.02: Configuring Services with Docker Compose

Services in Docker Compose are configured by environment variables. In this exercise, you will create a Docker Compose application that is configured by different methods of setting variables. In a file called `print.env`, you will define two environment variables. In addition, you will create and configure one environment variable in the `docker-compose.yml` file and pass one environment variable from the Terminal on the fly. You will see how four environment variables from different sources come together in your container.

To complete the exercise, execute the following steps:

1. Create a folder named `server-with-configuration` and navigate into it using the `cd` command:

```
mkdir server-with-configuration
cd server-with-configuration
```

2. Create an `.env` file with the name `print.env` and the following content:

```
ENV_FROM_ENV_FILE_1=HELLO
ENV_FROM_ENV_FILE_2=WORLD
```

In this file, two environment variables, `ENV_FROM_ENV_FILE_1` and `ENV_FROM_ENV_FILE_2`, are defined with their values.

3. Create a file with the name `docker-compose.yaml` and the following content:

```
version: "3"
services:
  print:
    image: busybox
    command: sh -c 'sleep 5 && env'
    env_file:
      - print.env
    environment:
      - ENV_FROM_COMPOSE_FILE=HELLO
      - ENV_FROM_SHELL
```

In this file, a single-container application is defined, and the container runs the `env` command to print the environment variables. It also uses the environment file named `print.env`, and two additional environment variables, `ENV_FROM_COMPOSE_FILE` and `ENV_FROM_SHELL`.

4. Export `ENV_FROM_SHELL` to the shell with the following command:

```
export ENV_FROM_SHELL=WORLD
```

5. Start the application with the `docker-compose up` command. The output should look like the following:

```
[ /docker-ws $ docker-compose up
WARNING: The Docker Engine you're using is running in swarm mode.

Compose does not use swarm mode to deploy services to multiple nodes in a swarm. All containers
will be scheduled on the current node.

To deploy your application across the swarm, use `docker stack deploy`.

Creating network "server-with-configuration_default" with the default driver
Creating server-with-configuration_print_1 ... done
Attaching to server-with-configuration_print_1
print_1 | PATH=/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin
print_1 | HOSTNAME=bd9029ae5476
print_1 | ENV_FROM_ENV_FILE_1=HELLO
print_1 | ENV_FROM_ENV_FILE_2=WORLD
print_1 | ENV_FROM_COMPOSE_FILE=HELLO
print_1 | ENV_FROM_SHELL=WORLD
print_1 | HOME=/root
server-with-configuration_print_1 exited with code 0
/docker-ws $
```

The output is the result of the `print` container defined in the `docker-compose` file. The container has one command to run, `env`, and it prints the available environment variables. As expected, there are two environment variables, `ENV_FROM_ENV_FILE_1` and `ENV_FROM_ENV_FILE_2`, with the corresponding values of `HELLO` and `WORLD`. In addition, the environment variable defined in the `docker-compose.yaml` file in *step 3* is available with the name `ENV_FROM_COMPOSE_FILE` and the value `HELLO`. Finally, the environment variable exported in *step 4* is available with the name `ENV_FROM_SHELL` and the value `WORLD`.

In this exercise, a Docker Compose application was created and configured with different methods. Using Docker Compose files, environment definition files and exported values can be used to deploy the same application to different platforms.

In the following exercise, the order of containers will be used to fill the contents of a file and then serve it with a web server.

Exercise 5.03: Service Dependency with Docker Compose

Services in Docker Compose can be configured to depend on other services. In this exercise, you will create an application with four containers. The first three containers will run consecutively to create a static file that will be served by the fourth container.

To complete the exercise, execute the following steps:

1. Create a folder named `server-with-dependency` and navigate into it using the `cd` command:

```
mkdir server-with-dependency
cd server-with-dependency
```

2. Create a file with the name `docker-compose.yaml` and the following content:

```
version: "3"
services:
  clean:
    image: busybox
    command: "rm -rf /static/index.html"
    volumes:
      - static:/static
  init:
    image: busybox
    command: "sh -c 'echo This is from init container >>
/static/index.html'"
    volumes:
      - static:/static
    depends_on:
      - "clean"
  pre:
    image: busybox
    command: "sh -c 'echo This is from pre container >>
/static/index.html'"
    volumes:
      - static:/static
    depends_on:
      - "init"
  server:
```

```

image: nginx
volumes:
  - static:/usr/share/nginx/html
ports:
  - "8080:80"
depends_on:
  - "pre"
volumes:
  static:

```

This file consists of four services and one volume. The volume is named `static`, and it is mounted to all services. The first three services take individual actions on the static volume. The `clean` container removes the `index.html` file, and then the `init` container starts filling `index.html`. Following that, the `pre` container writes an additional line to the `index.html` file. Finally, the `server` container serves the content in the `static` folder.

3. Start the application with the `docker-compose up` command. The output should look like the following:

```

[ /docker-ws $ docker-compose up
WARNING: The Docker Engine you're using is running in swarm mode.

Compose does not use swarm mode to deploy services to multiple nodes in a swarm. All containers
will be scheduled on the current node.

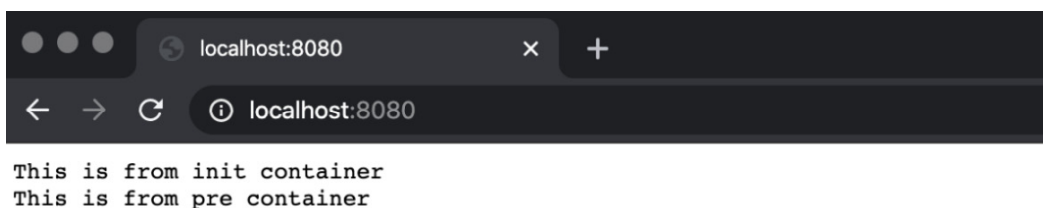
To deploy your application across the swarm, use `docker stack deploy`.

Creating server-with-dependency_clean_1 ... done
Creating server-with-dependency_init_1 ... done
Creating server-with-dependency_pre_1 ... done
Creating server-with-dependency_server_1 ... done
Attaching to server-with-dependency_clean_1, server-with-dependency_init_1, server-with-dependency_pre_1, server-with-dependency_server_1
server-with-dependency_clean_1 exited with code 0
server-with-dependency_init_1 exited with code 0
server-with-dependency_pre_1 exited with code 0

```

The output shows that Docker Compose creates the containers in the order of `clean`, `init`, and then `pre`.

4. Open `http://localhost:8080` in the browser:



The output from the server shows that the `clean`, `init`, and `pre` containers work in the expected order.

5. Return to the Terminal in *step 3* and use `Ctrl + C` to close the application gracefully. You will see some HTTP request logs and, in the end, the `Stopping server-with-dependency_server_1` line:


```
[ /docker-ws $ docker-compose up ]
WARNING: The Docker Engine you're using is running in swarm mode.

Compose does not use swarm mode to deploy services to multiple nodes in a swarm. All containers
will be scheduled on the current node.

To deploy your application across the swarm, use `docker stack deploy`.

Creating server-with-dependency_clean_1 ... done
Creating server-with-dependency_init_1 ... done
Creating server-with-dependency_pre_1 ... done
Creating server-with-dependency_server_1 ... done
Attaching to server-with-dependency_clean_1, server-with-dependency_init_1, server-with-dependency_pre_1, server-with-dependency_server_1
server-with-dependency_clean_1 exited with code 0
server-with-dependency_init_1 exited with code 0
server-with-dependency_pre_1 exited with code 0
server_1 | 192.168.32.1 - - [06/Jan/2020:11:04:44 +0000] "GET / HTTP/1.1" 200 55 "-" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_15_2) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/79.0.3945.88 Safari/537.36" "-"
server_1 | 2020/01/06 11:04:45 [error] 6#6: *1 open() "/usr/share/nginx/html/favicon.ico" failed (2: No such file or directory), client: 192.168.32.1, server: localhost, request: "GET /favicon.ico HTTP/1.1", host: "localhost:8080", referer: "http://localhost:8080/"
server_1 | 192.168.32.1 - - [06/Jan/2020:11:04:45 +0000] "GET /favicon.ico HTTP/1.1" 404 555 "http://localhost:8080/" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_15_2) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/79.0.3945.88 Safari/537.36" "-"
^CGracefully stopping... (press Ctrl+C again to force)
Stopping server-with-dependency_server_1 ... done
/docker-ws $
```

In this exercise, a Docker Compose application was created with interdependent services. How Docker Compose starts and manages containers in a defined order was shown. This is an essential feature of Docker Compose with which you can create complex multi-container applications.

Now, let's test the knowledge we have gained so far in this lab by implementing the following activity. In the next activity, you will learn how to install WordPress using Docker Compose.

Activity 5.01: Installing WordPress Using Docker Compose

You are assigned to design and deploy a blog with its database as microservices in Docker. You will be using **WordPress** since it is the most popular **Content Management System (CMS)**, used by more than one-third of all the websites on the internet. Also, the development and testing teams require the installation of both WordPress and the database multiple times on different platforms with isolation. Therefore, you are required to design it as a Docker Compose application and manage it with the `docker-compose` CLI.

Perform the following steps to complete this activity:

1. Start by creating a directory for your `docker-compose.yaml` file.
2. Create a service for the database using MySQL and a volume defined in the `docker-compose.yaml` file. Ensure that the `MYSQL_ROOT_PASSWORD`, `MYSQL_DATABASE`, `MYSQL_USER`, and `MYSQL_PASSWORD` environment variables are set.
3. Create a service for WordPress defined in the `docker-compose.yaml` file. Ensure that the WordPress containers start after the database. For the configuration of WordPress, do not forget to set the `WORDPRESS_DB_HOST`, `WORDPRESS_DB_USER`, `WORDPRESS_DB_PASSWORD`, and `WORDPRESS_DB_NAME` environment variables in accordance with *step 2*. In addition, you need to publish its port to be able to reach it from the browser.
4. Start the Docker Compose application in `detached` mode. Upon successful deployment, you will have two containers running:

```

/docker-ws $ docker-compose ps

```

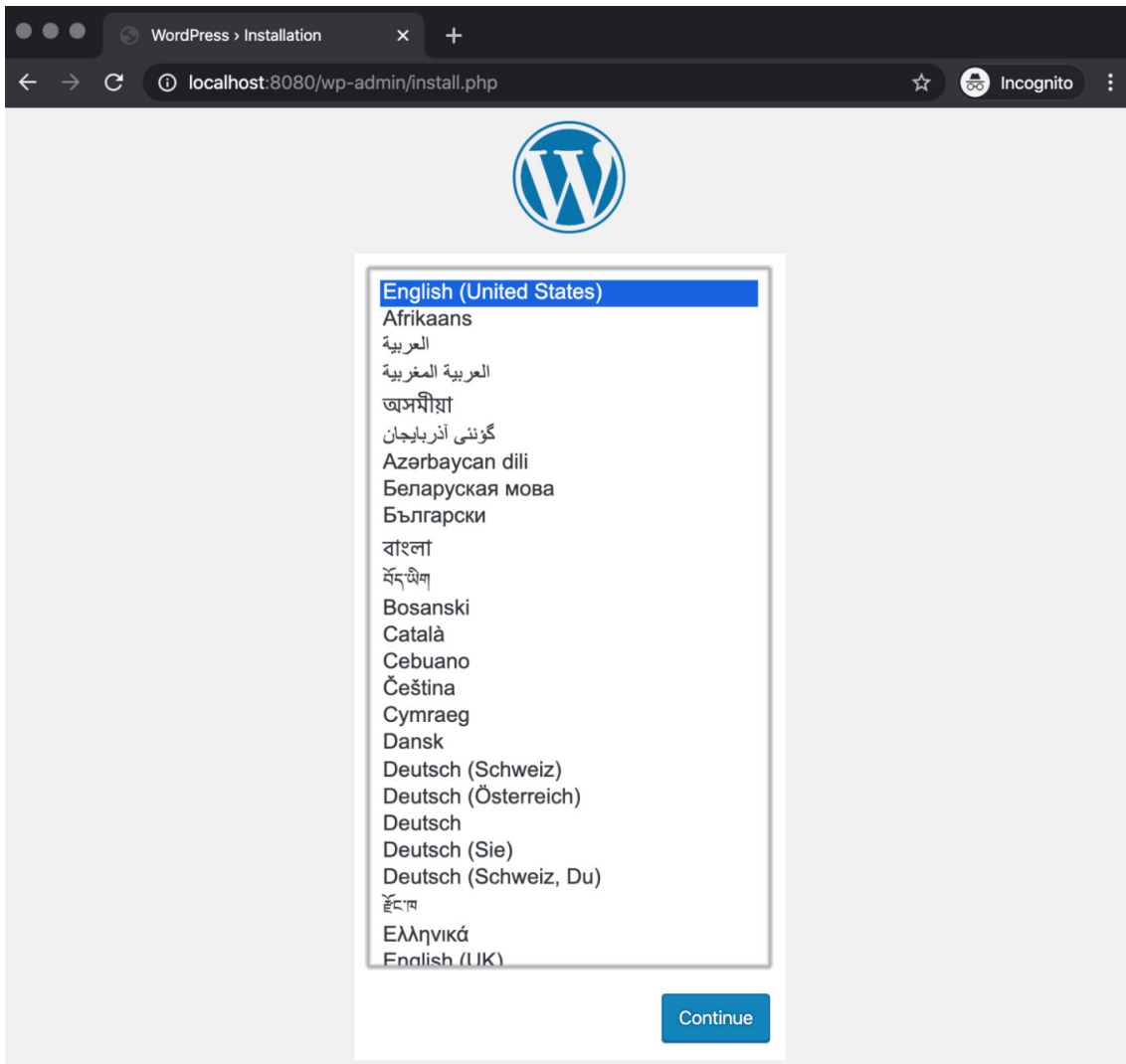
Name	Command	State	Ports
wordpress_database_1	docker-entrypoint.sh mysqld	Up	3306/tcp, 33060/tcp
wordpress_wordpress_1	docker-entrypoint.sh apach ...	Up	0.0.0.0:8080->80/tcp

```

/docker-ws $

```

You will then be able to reach the setup screen of WordPress in the browser:



In the next activity, you will get hands-on experience installing the Panoramic Trekking App using Docker Compose by creating a three-container Docker application and managing it with the `docker-compose` CLI.

Activity 5.02: Installing the Panoramic Trekking App Using Docker Compose

You are tasked with creating a deployment of the Panoramic Trekking App using Docker Compose. You will take advantage of the three-tier architecture of the Panoramic Trekking App and create a three-container Docker

application, with containers for the database, the web backend, and `nginx`. Therefore, you will design it as a Docker Compose application and manage it with the `docker-compose` CLI.

Perform the following steps to complete this activity:

1. Create a directory for your `docker-compose.yaml` file.
2. Create a service for the database using PostgreSQL and a volume defined in the `docker-compose.yaml` file. Ensure that the `POSTGRES_PASSWORD` environment variable is set to `docker`. In addition, you need to create a `db_data` volume in `docker-compose.yaml` and mount it to the `/var/lib/postgresql/data/` to store the database files.
3. Create a service for the Panoramic Trekking App defined in the `docker-compose.yaml` file. Ensure that you are using the `fenago/docker-course:lab5-pta-web` Docker image, which is prebuilt and ready to use from the registry. In addition, since the application is dependent on the database, you should configure the container to start after the database. To store the static files, create a `static_data` volume in `docker-compose.yaml` and mount it to `/service/static/`.

Finally, create a service for `nginx` and ensure that you are using the `fenago/docker-course:lab5-pta-nginx` Docker image from the registry. Ensure that the `nginx` container starts after the Panoramic Trekking App container. You also need to mount the same `static_data` volume to the `/service/static/` location. Do not forget to publish `nginx` port `80` to `8000` to reach from the browser.

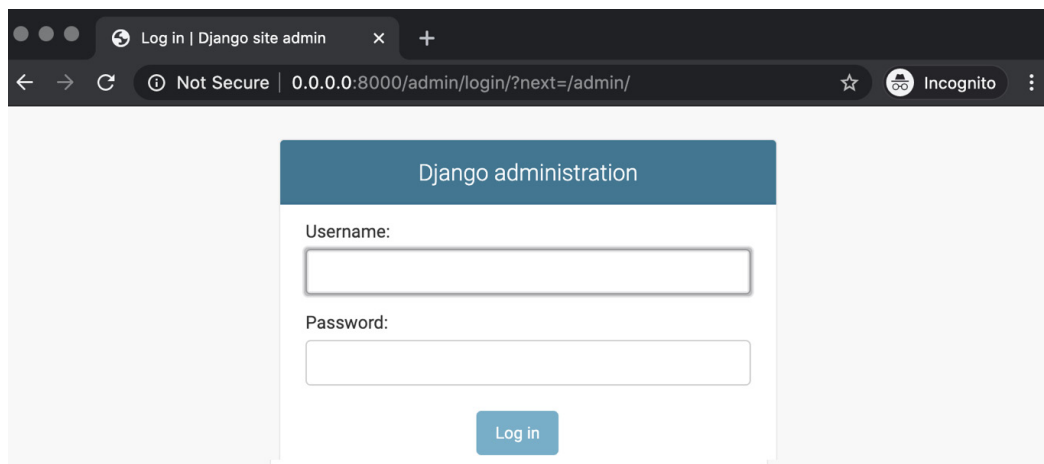
4. Start the Docker Compose application in `detached` mode. Upon successful deployment, you will have three containers running:

```
/docker-ws $ docker-compose ps
```

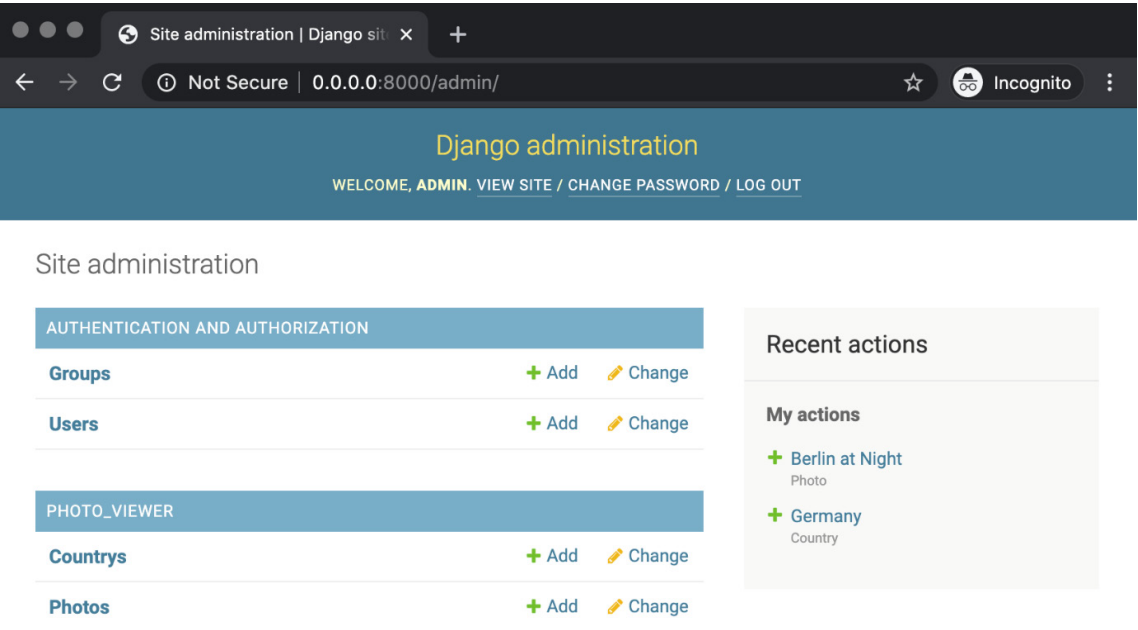
Name	Command	State	Ports
pta-compose_db_1	docker-entrypoint.sh postgres	Up	5432/tcp
pta-compose_nginx_1	nginx -g daemon off;	Up	0.0.0.0:8000->80/tcp
pta-compose_web_1	./entrypoint.sh gunicorn p ...	Up	

```
/docker-ws $
```

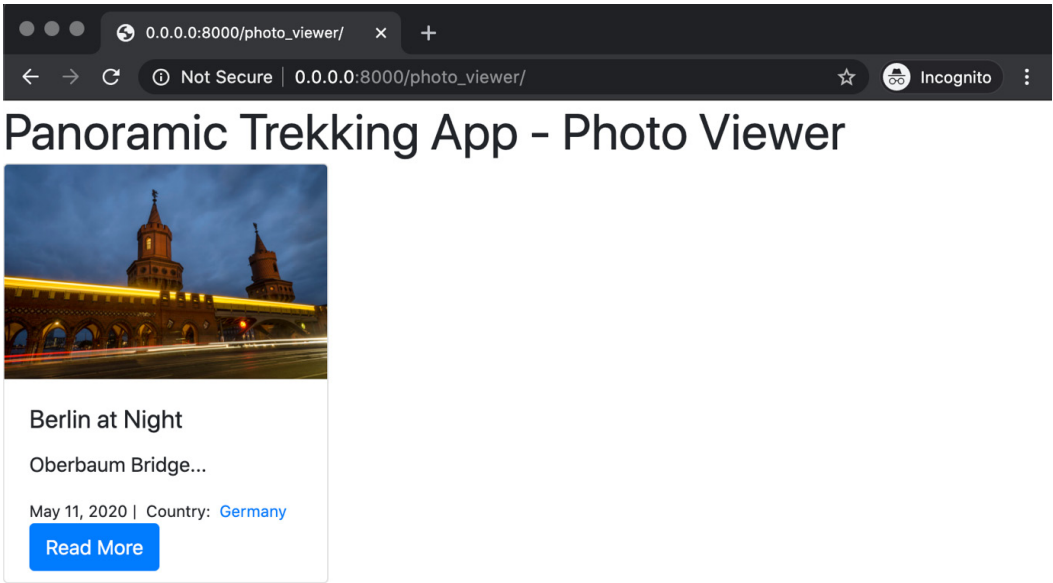
5. Go to the administration section of the Panoramic Trekking App in the browser with the address `http://0.0.0.0:8000/admin`:



You can log in with the username `admin` and password `changeme` and add new photos and countries:



6. Access the Panoramic Trekking App at the address `http://0.0.0.0:8000/photo_viewer` in the browser:



Summary

In this lab, the main focus was to learn `docker-compose` comprehensively. With this aim, the lab started with the capabilities of the `docker-compose` CLI with its commands and flags. Then, the anatomy of `docker-compose.yaml` files was presented. The power of Docker Compose actually comes from the configuration capabilities defined in the `docker-compose.yaml` files. Therefore, it is essential to learn how to use these files to manage multi-container applications.

Following that, the configuration of services in Docker Compose was illustrated. You have learned how to configure services for different environments and adapt to changes in the future. We then moved on to service dependencies to learn how to create more complex containerized applications.

In the next lab, you will learn about networking in Docker.