Get Started, Part 1: Orientation and Setup

Estimated reading time: 3 minutes

Welcome! We are excited you want to learn how to use Docker.

In this two-part tutorial, you will:

1. Get set up and oriented, on this page.
2. Build and run your first app

The application itself is very simple so that you are not too distracted by what the code is doing. After all, the value of Docker is in how it can build, ship, and run applications; it's totally agnostic as to what your application actually does.

Prerequisites

While we'll define concepts along the way, it is good for you to understand what Docker is and why you would use Docker before we begin.

We also need to assume you are familiar with a few concepts before we continue:

- IP Addresses and Ports
- Virtual Machines
- Editing configuration files
- Basic familiarity with the ideas of code dependencies and building
- Machine resource usage terms, like CPU percentages, RAM use in bytes, etc.

A brief explanation of containers

An **image** is a lightweight, stand-alone, executable package that includes everything needed to run a piece of software, including the code, a runtime, libraries, environment variables, and config files.

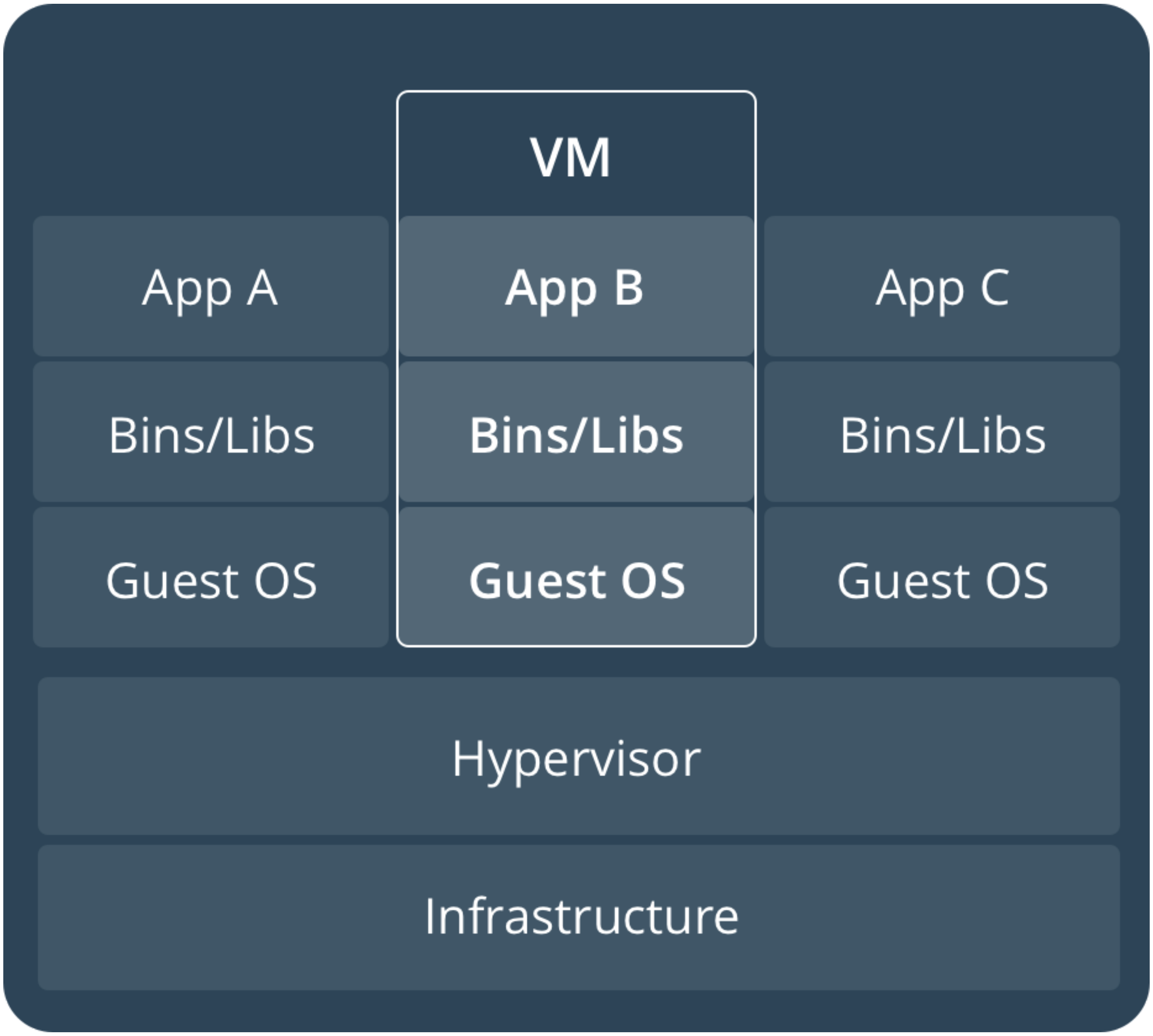
A **container** is a runtime instance of an image—what the image becomes in memory when actually executed. It runs completely isolated from the host environment by default, only accessing host files and ports if configured to do so.

Containers run apps natively on the host machine's kernel. They have better performance characteristics than virtual machines that only get virtual access to host resources through a hypervisor. Containers can get native access, each one running in a discrete process, taking no more memory than any other executable.

Containers vs. virtual machines

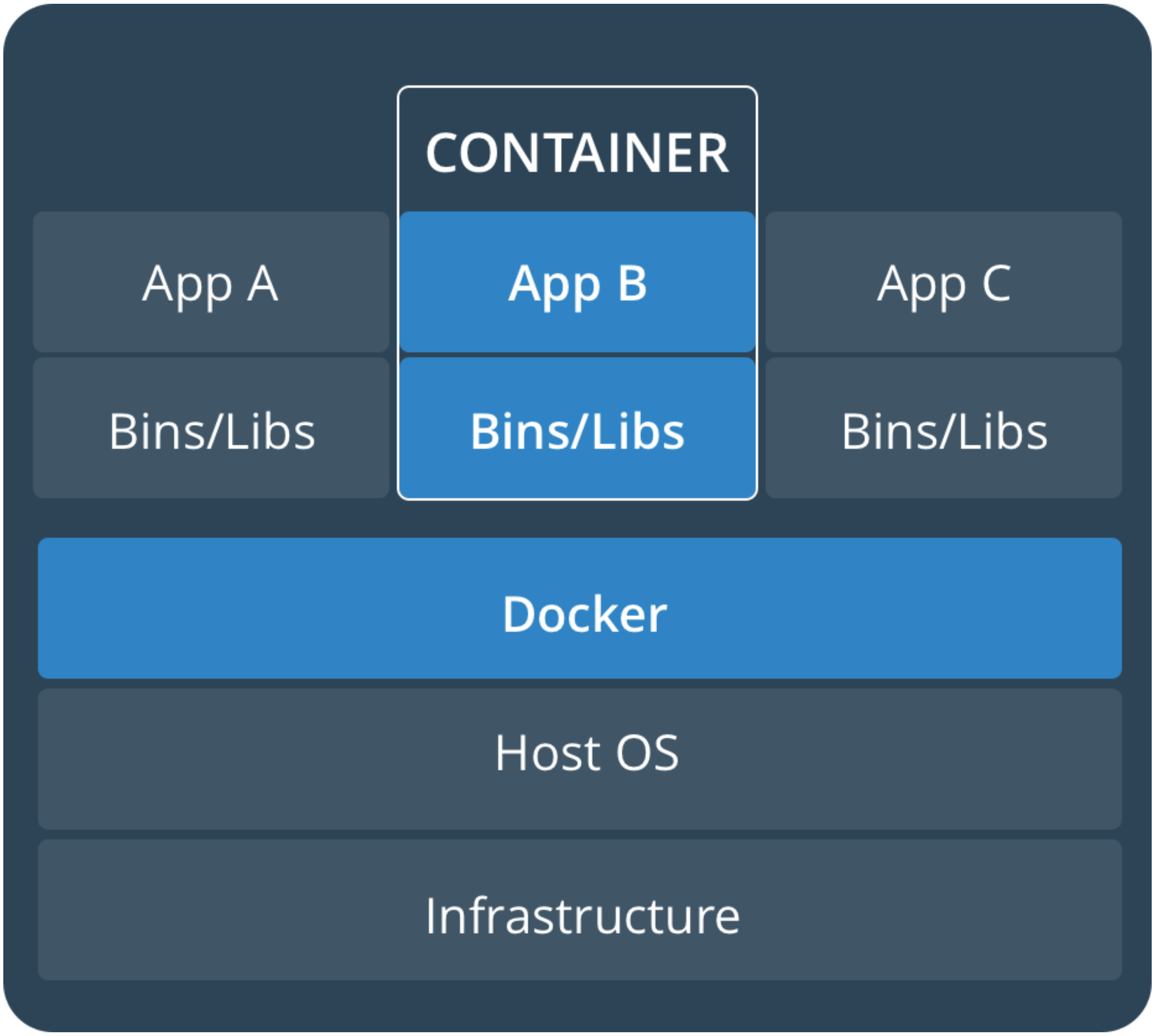
Consider this diagram comparing virtual machines to containers:

Virtual Machine diagram



Virtual machines run guest operating systems—note the OS layer in each box. This is resource intensive, and the resulting disk image and application state is an entanglement of OS settings, system-installed dependencies, OS security patches, and other easy-to-lose, hard-to-replicate ephemera.

Container diagram



Containers can share a single kernel, and the only information that needs to be in a container image is the executable and its package dependencies, which never need to be installed on the host system. These processes run like native processes, and you can manage them individually by running commands like `docker ps`—just like you would run `ps` on Linux to see active processes. Finally, because they contain all their dependencies, there is no configuration entanglement; a containerized app “runs anywhere.”

Setup

Before we get started, make sure your system has the latest version of Docker installed.

Install Docker

> **Note**: version 1.13 or higher is required

You should be able to run `docker run hello-world` and see a response like this:

```
$ docker run hello-world

Hello from Docker!
This message shows that your installation appears to be working correctly.

To generate this message, Docker took the following steps:
...(snipped)...
```

Now would also be a good time to make sure you are using version 1.13 or higher. Run `docker --version` to check it out.

```
$ docker --version
Docker version 17.05.0-ce-rc1, build 2878a85
```

If you see messages like the ones above, you are ready to begin your journey.

Conclusion

The unit of scale being an individual, portable executable has vast implications. It means CI/CD can push updates to any part of a distributed application, system dependencies are not an issue, and resource density is increased. Orchestration of scaling behavior is a matter of spinning up new executables, not new VM hosts.

We'll be learning about all of these things, but first let's learn to walk.

Get Started, Part 2: Containers

Estimated reading time: 12 minutes

Prerequisites

- Install Docker version 1.13 or higher.
- Read the orientation in Part 1.
- Give your environment a quick test run to make sure you're all set up:

  ```
  docker run hello-world
  ```

Introduction

It's time to begin building an app the Docker way. We'll start at the bottom of the hierarchy of such an app, which is a container, which we cover on this page. Above this level is a service, which defines how containers behave in production, covered in Part 3. Finally, at the top level is the stack, defining the interactions of all the services, covered in Part 5.

- Stack
- Services
- **Container** (you are here)

Your new development environment

In the past, if you were to start writing a Python app, your first order of business was to install a Python runtime onto your machine. But, that creates a situation where the environment on your machine has to be just so in order for your app to run as expected; ditto for the server that runs your app.

With Docker, you can just grab a portable Python runtime as an image, no installation necessary. Then, your build can include the base Python image right alongside your app code, ensuring that your app, its dependencies, and the runtime, all travel together.

These portable images are defined by something called a `Dockerfile`.

Define a container with a `Dockerfile`

`Dockerfile` will define what goes on in the environment inside your container. Access to resources like networking interfaces and disk drives is virtualized inside this environment, which is isolated from the rest of your system, so you have to map ports to the outside world, and be specific about what files you want to “copy in” to that environment. However, after doing that, you can expect that the build of your app defined in this `Dockerfile` will behave exactly the same wherever it runs.

`Dockerfile`

Create an empty directory. Change directories (`cd`) into the new directory, create a file called `Dockerfile`, copy-and-paste the following content into that file, and save it. Take note of the comments that explain each statement in your new Dockerfile.

```
# Use an official Python runtime as a parent image
FROM python:2.7-slim

# Set the working directory to /app
WORKDIR /app

# Copy the current directory contents into the container at /app
ADD . /app

# Install any needed packages specified in requirements.txt
RUN pip install -r requirements.txt

# Make port 80 available to the world outside this container
EXPOSE 80

# Define environment variable
ENV NAME World

# Run app.py when the container launches
CMD ["python", "app.py"]
```

This `Dockerfile` refers to a couple of files we haven’t created yet, namely `app.py` and `requirements.txt`. Let’s create those next.

The app itself

Create two more files, `requirements.txt` and `app.py`, and put them in the same folder with the `Dockerfile`. This completes our app, which as you can see is quite simple. When the above `Dockerfile` is built into an image, `app.py` and `requirements.txt` will be present because of that `Dockerfile`’s `ADD` command, and the output from `app.py` will be accessible over HTTP thanks to the `EXPOSE` command.

`requirements.txt`

```
Flask
Redis
```

`app.py`

```
from flask import Flask
from redis import Redis, RedisError
import os
import socket

# Connect to Redis
redis = Redis(host="redis", db=0, socket_connect_timeout=2, socket_timeout=

app = Flask(__name__)

@app.route("/")
def hello():
    try:
        visits = redis.incr("counter")
    except RedisError:
        visits = "<i>cannot connect to Redis, counter disabled</i>"

    html = "<h3>Hello {name}!</h3>" \
           "<b>Hostname:</b> {hostname}<br/>" \
           "<b>Visits:</b> {visits}"
    return html.format(name=os.getenv("NAME", "world"), hostname=socket.get

if __name__ == "__main__":
    app.run(host='0.0.0.0', port=80)
```

Now we see that `pip install -r requirements.txt` installs the Flask and Redis libraries for Python, and the app prints the environment variable `NAME`, as well as the output of a call to `socket.gethostname()`. Finally, because Redis isn't running (as we've only installed the Python library, and not Redis itself), we should expect that the attempt to use it here will fail and produce the error message.

> **Note**: Accessing the name of the host when inside a container retrieves the container ID, which is like the process ID for a running executable.

That's it! You don't need Python or anything in `requirements.txt` on your system, nor will building or running this image install them on your system. It doesn't seem like you've really set up an environment with Python and Flask, but you have.

Build the app

We are ready to build the app. Make sure you are still at the top level of your new directory. Here's what `ls` should show:

```
$ ls
Dockerfile              app.py                  requirements.txt
```

Now run the build command. This creates a Docker image, which we're going to tag using `-t` so it has a friendly name.

```
docker build -t friendlyhello .
```

Where is your built image? It's in your machine's local Docker image registry:

```
$ docker images

REPOSITORY            TAG                 IMAGE ID
friendlyhello         latest              326387cea398
```

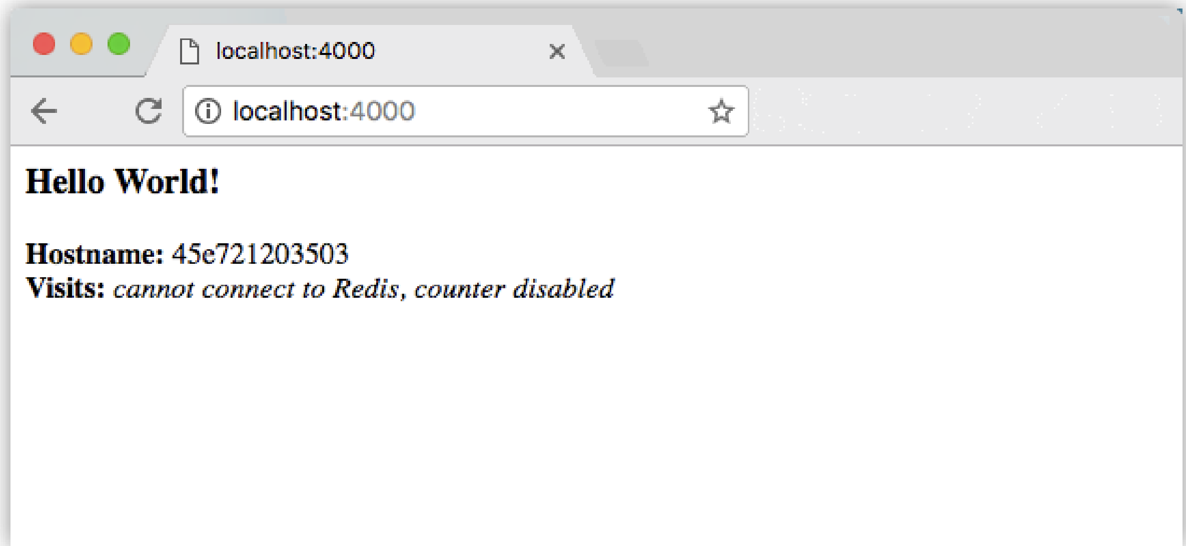
Run the app

Run the app, mapping your machine's port 4000 to the container's `EXPOSE`d port 80 using `-p`:

```
docker run -p 4000:80 friendlyhello
```

You should see a notice that Python is serving your app at `http://0.0.0.0:80`. But that message is coming from inside the container, which doesn't know you mapped port 80 of that container to 4000, making the correct URL `http://localhost:4000`.

Go to that URL in a web browser to see the display content served up on a web page, including "Hello World" text, the container ID, and the Redis error message.



You can also use the `curl` command in a shell to view the same content.

```
$ curl http://localhost:4000

<h3>Hello World!</h3><b>Hostname:</b> 8fc990912a14<br/><b>Visits:</b> <i>ca
```

> **Note**: This port remapping of `4000:80` is to demonstrate the difference between what you `EXPOSE` within the `Dockerfile`, and what you `publish` using `docker run -p`. In later steps, we'll just map port 80 on the host to port 80 in the container and use `http://localhost`.

Hit `CTRL+C` in your terminal to quit.

Now let's run the app in the background, in detached mode:

```
docker run -d -p 4000:80 friendlyhello
```

You get the long container ID for your app and then are kicked back to your terminal. Your container is running in the background. You can also see the abbreviated container ID with `docker ps` (and both work interchangeably when running commands):

```
$ docker ps
CONTAINER ID        IMAGE               COMMAND             CREATED
```

```
1fa4ab2cf395        friendlyhello       "python app.py"     28 seconds ago
```

You'll see that `CONTAINER ID` matches what's on `http://localhost:4000`.

Now use `docker stop` to end the process, using the `CONTAINER ID`, like so:

```
docker stop 1fa4ab2cf395
```

Share your image

To demonstrate the portability of what we just created, let's upload our built image and run it somewhere else. After all, you'll need to learn how to push to registries when you want to deploy containers to production.

A registry is a collection of repositories, and a repository is a collection of images—sort of like a GitHub repository, except the code is already built. An account on a registry can create many repositories. The `docker` CLI uses Docker's public registry by default.

> **Note**: We'll be using Docker's public registry here just because it's free and pre-configured, but there are many public ones to choose from, and you can even set up your own private registry using Docker Trusted Registry.

Log in with your Docker ID

If you don't have a Docker account, sign up for one at cloud.docker.com. Make note of your username.

Log in to the Docker public registry on your local machine.

```
docker login
```

Tag the image

The notation for associating a local image with a repository on a registry is `username/repository:tag`. The tag is optional, but recommended, since it is the mechanism that registries use to give Docker images a version. Give the repository and tag meaningful names for the context, such as `get-started:part1`. This will put the image in the `get-started` repository and tag it as `part1`.

Now, put it all together to tag the image. Run `docker tag image` with your username, repository, and tag names so that the image will upload to your desired destination. The syntax of the command is:

```
docker tag image username/repository:tag
```

For example:

```
docker tag friendlyhello john/get-started:part1
```

Run docker images to see your newly tagged image. (You can also use `docker image ls`.)

```
$ docker images
REPOSITORY               TAG                 IMAGE ID            CREATED
friendlyhello            latest              d9e555c53008        3 minutes
john/get-started         part1               d9e555c53008        3 minutes
python                   2.7-slim            1c7128a655f6        5 days ago
...
```

Publish the image

Upload your tagged image to the repository:

```
docker push username/repository:tag
```

Once complete, the results of this upload are publicly available. If you log in to Docker Hub, you will see the new image there, with its pull command.

Pull and run the image from the remote repository

From now on, you can use `docker run` and run your app on any machine with this command:

```
docker run -p 4000:80 username/repository:tag
```

If the image isn't available locally on the machine, Docker will pull it from the repository.

```
$ docker run -p 4000:80 john/get-started:part1
Unable to find image 'john/get-started:part1' locally
part1: Pulling from orangesnap/get-started
10a267c67f42: Already exists
f68a39a6a5e4: Already exists
9beaffc0cf19: Already exists
3c1fe835fb6b: Already exists
4c9f1fa8fcb8: Already exists
ee7d8f576a14: Already exists
fbccdcced46e: Already exists
Digest: sha256:0601c866aab2adcc6498200efd0f754037e909e5fd42069adeff72d1e243
Status: Downloaded newer image for john/get-started:part1
 * Running on http://0.0.0.0:80/ (Press CTRL+C to quit)
```

> **Note**: If you don't specify the `:tag` portion of these commands, the tag of `:latest` will be assumed, both when you build and when you run images. Docker will use the last version of the image that ran without a tag specified (not necessarily the most recent image).

No matter where `docker run` executes, it pulls your image, along with Python and all the dependencies from `requirements.txt`, and runs your code. It all travels together in a neat little package, and the host machine doesn't have to install anything but Docker to run it.