Containers for Beginners
Intro to Docker

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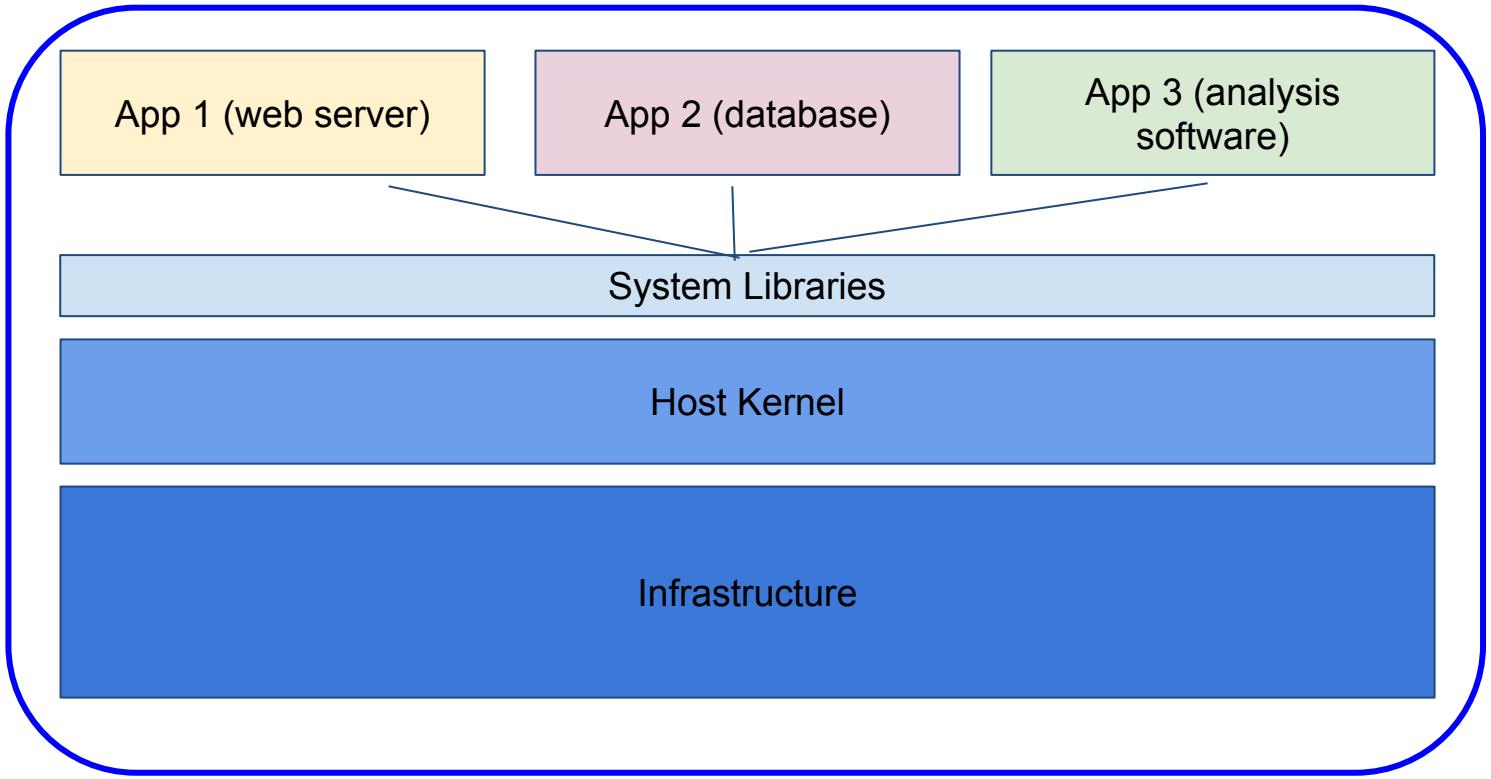
Objectives

- What are containers? - Which problems are we trying to solve
- What is Docker and how it can help us
- A Simple Docker application
  - how to run a container
  - how to build a container
  - inspecting images
- Docker registry: How to publish containers
- Building applications with multiple components: docker-compose.

What problems are we trying to solve?

Developing, Building, Deploying and Maintaining complex applications involves facing a number of issues including :

- managing a complex software stack
- compatibility between applications
- portability
- reproducibility



What problems are we trying to solve?

- **Complex software stack :**
  Building applications often requires a complex set of dependencies, specific versions of libraries, not always easy to manage on all operating systems.

- **Compatibility :**
  Different applications might have conflicting requirements so setting up a system that can host multiple applications is not always easy.

- **Portability :**
  Replicating a software setup on a different host, or between a development and production environment requires the environments to match perfectly, which is often hard to achieve.

- **Reproducibility :**
  Applications behavior might be affected in unexpected way by changes to the host environment.

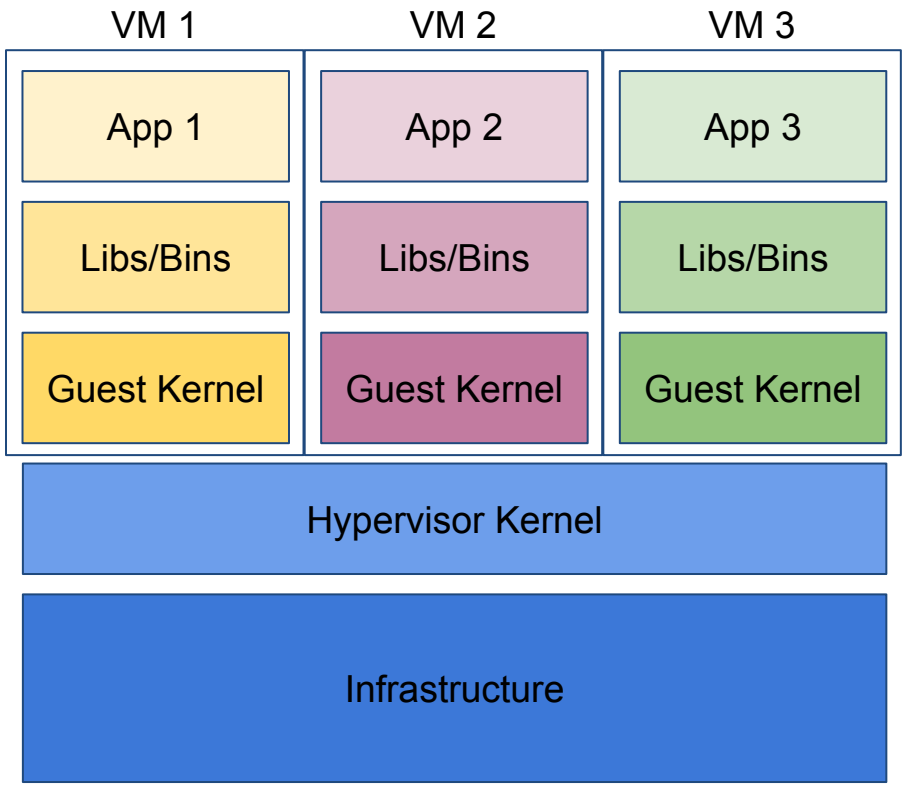
Containers

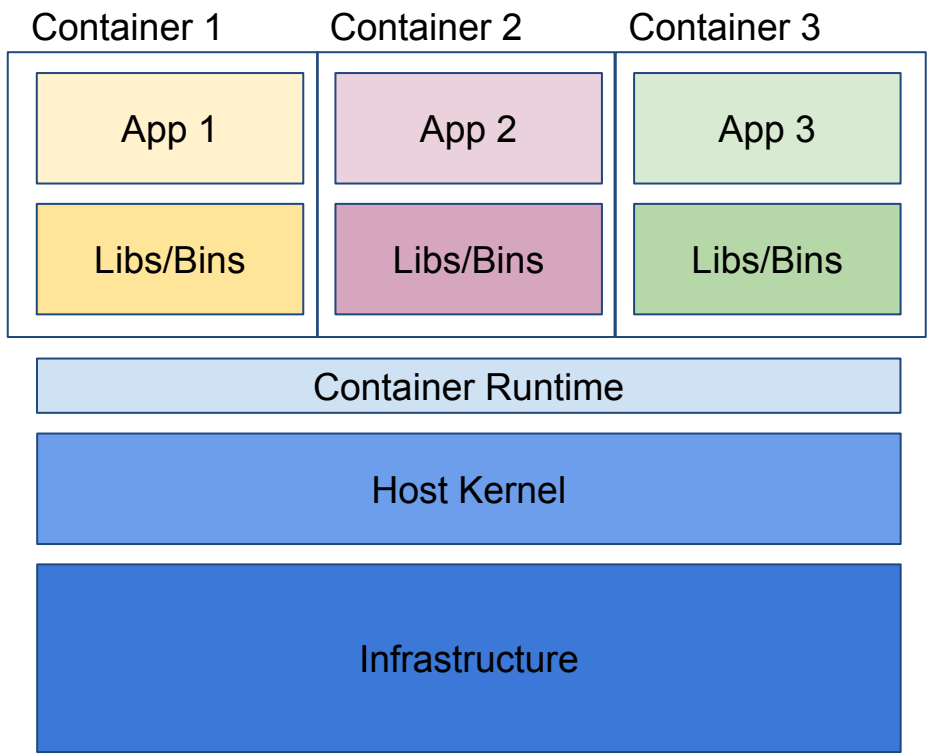
Containers provide a great solution to our problems :

A **container** is a set of processes (typically 1) which is isolated from the rest of the operating system and can only see the specific libraries necessary to run them. This allows

- Easier software deployment:
  Users can leverage on installation tools that do not need to be available natively on the runtime host (e.g. package managers of various linux distributions).
- Software can be built on a platform different from the execution hosts.
- All necessary dependencies are packaged in one single object.
- Easy to publish and sign
- This ensure portability and reproducibility of the application stack on different production hosts, or between development and production environments.

VMs vs Containers

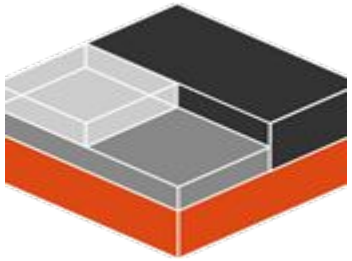




VMs:
hardware virtualization + OS

Containers:
User defined software stack

Linux container systems



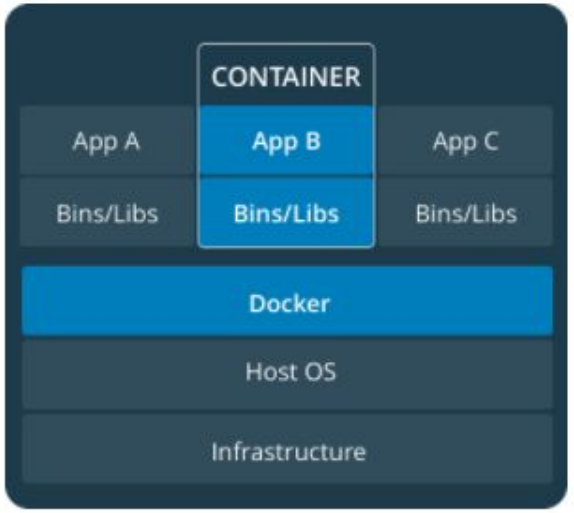
Linux LXC

podman

rkt

Docker Basics

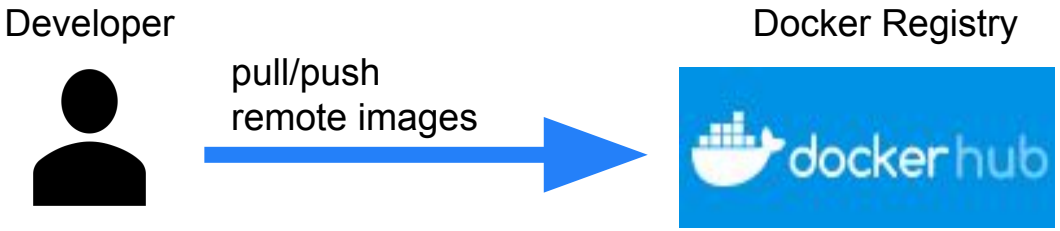
Docker packages software environments into **containers**, making it easy to share code without worrying about dependency installations, OS compatibility, or versioning issues.

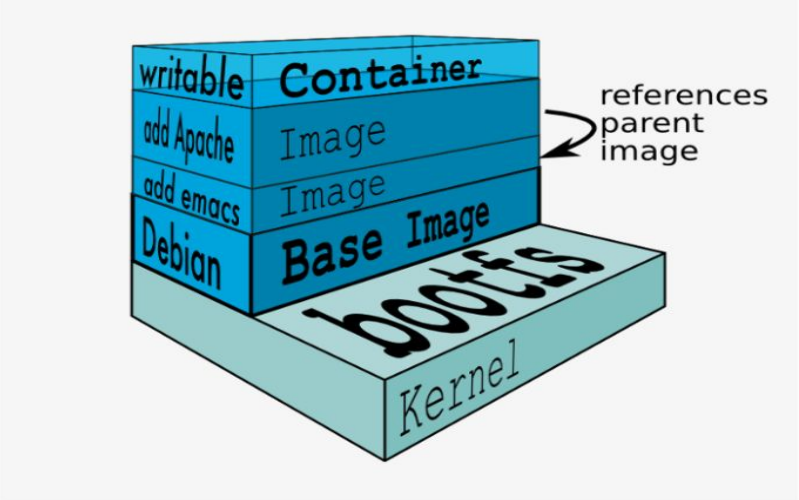


https://docs.docker.com/get-started/

Key Terms

- **Container**
  - Package of libraries and dependencies
  - Isolated from host
  - "**docker run**" command creates a container
- **Image**
  - Read-only snapshot of a container
  - Instantiate an image with one or many containers
  - Share images on Docker Registry (eg, Docker Hub)
  - "**docker build**" command creates an image





https://medium.com/docker-captain/docker-basics-f1a06fde18fb

Install Docker

Install Docker Desktop

– https://docs.docker.com/get-docker/

Verify Installation

– **docker --version**
  Prints out docker version.

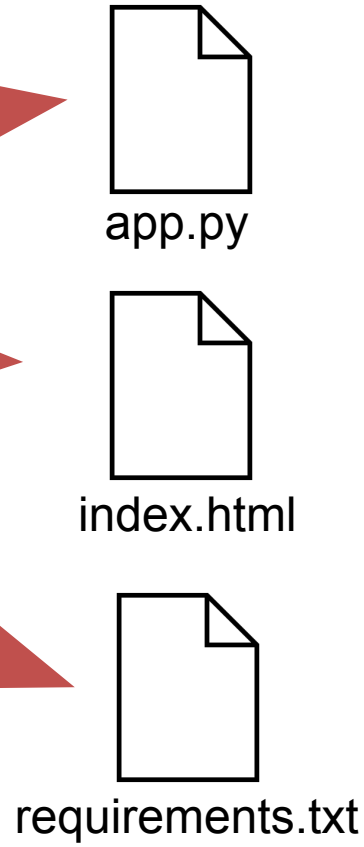
– **docker run hello-world**
  Output should include "your installation appears to be working correctly".

Simple Example of Docker project

As an example, we will make a simple web app.

We will use three files:

1. app.py – server
2. template/index.html – html
3. requirements.txt – dependencies



https://github.com/pontiggi/simple-docker , adapted from https://github.com/docker/labs/blob/master/beginner/chapters/webapps.md

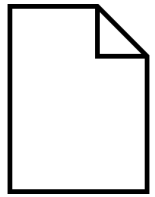
Running the app **without Docker**

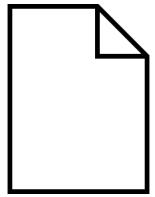
Deal with OS compatibility and versioning issues!

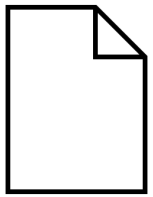
1. Install/update software (here, Python/pip)

2. Install other dependencies

3. Run code ("python app.py")

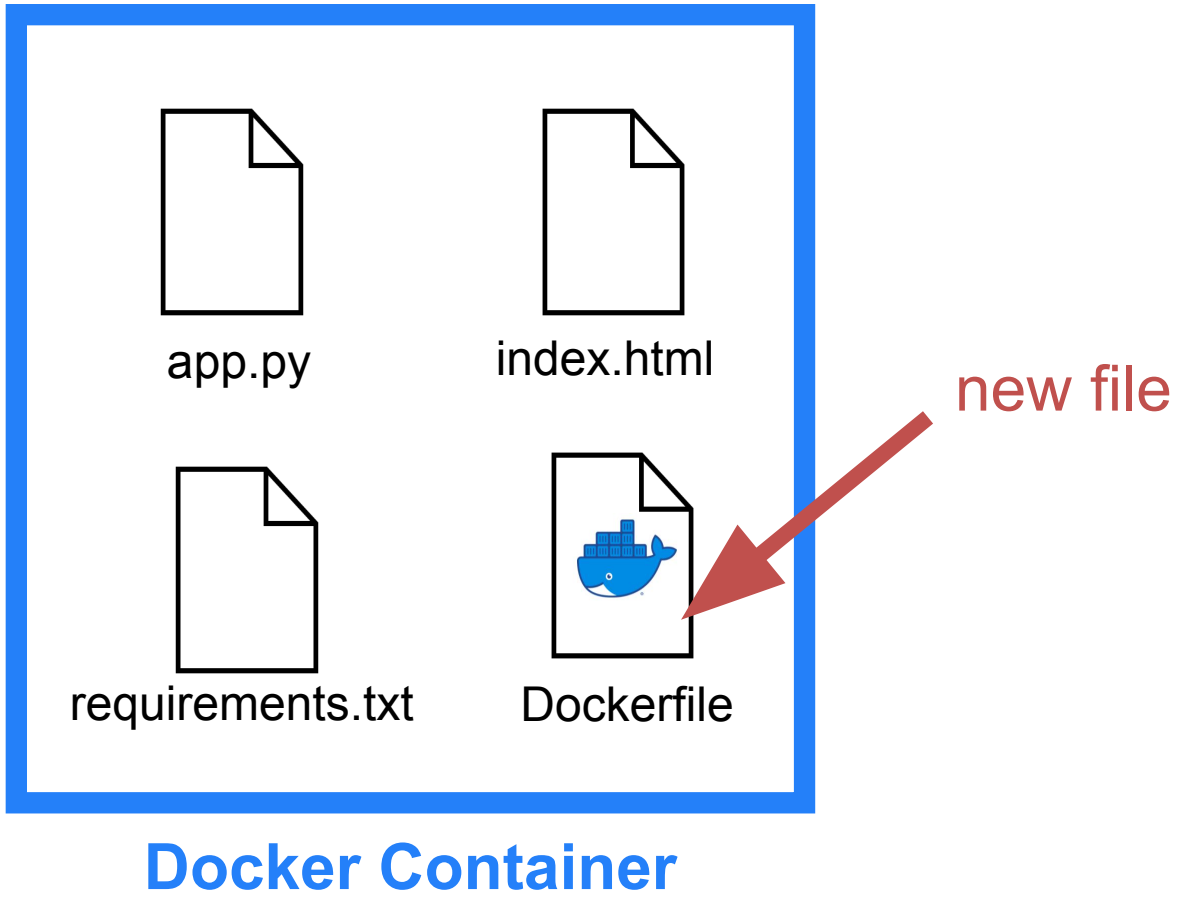

app.py


index.html


requirements.txt

Running the app **with Docker**

1. “docker build …”
2. “docker run …. “



Example of Dockerfile

1. Install/update software (here, Python/pip)
2. Install other dependencies
3. Run code ("python app.py")

```
>$ cat Dockerfile
# our base image
FROM alpine:latest
# Install python and pip
RUN apk add --update py3-pip

# install Python modules needed by the Python app
COPY requirements.txt /usr/src/app/
RUN pip3 install --no-cache-dir -r /usr/src/app/requirements.txt

# copy files required for the app to run
COPY app.py /usr/src/app/
COPY templates/index.html /usr/src/app/templates/

# tell the port number the container should expose
EXPOSE 5000
ENV BGCOLOR 'black'

# run the application
CMD ["python3", "/usr/src/app/app.py"]
```

Dockerfile Documentation
https://docs.docker.com/engine/reference/builder/

Docker Exercise - step 1 of 7

Verify Docker installation and run some basic docker commands

- **docker --version**

```
$> docker --version
Docker version 20.10.5, build 55c4c88
```

- **docker run hello-world**

  Output should include “your installation appears to be working correctly”.

- **docker run docker/whalesay cowsay Go Crimson**

(https://hub.docker.com/r/docker/whalesay/)

Docker Exercise - step 2 of 7

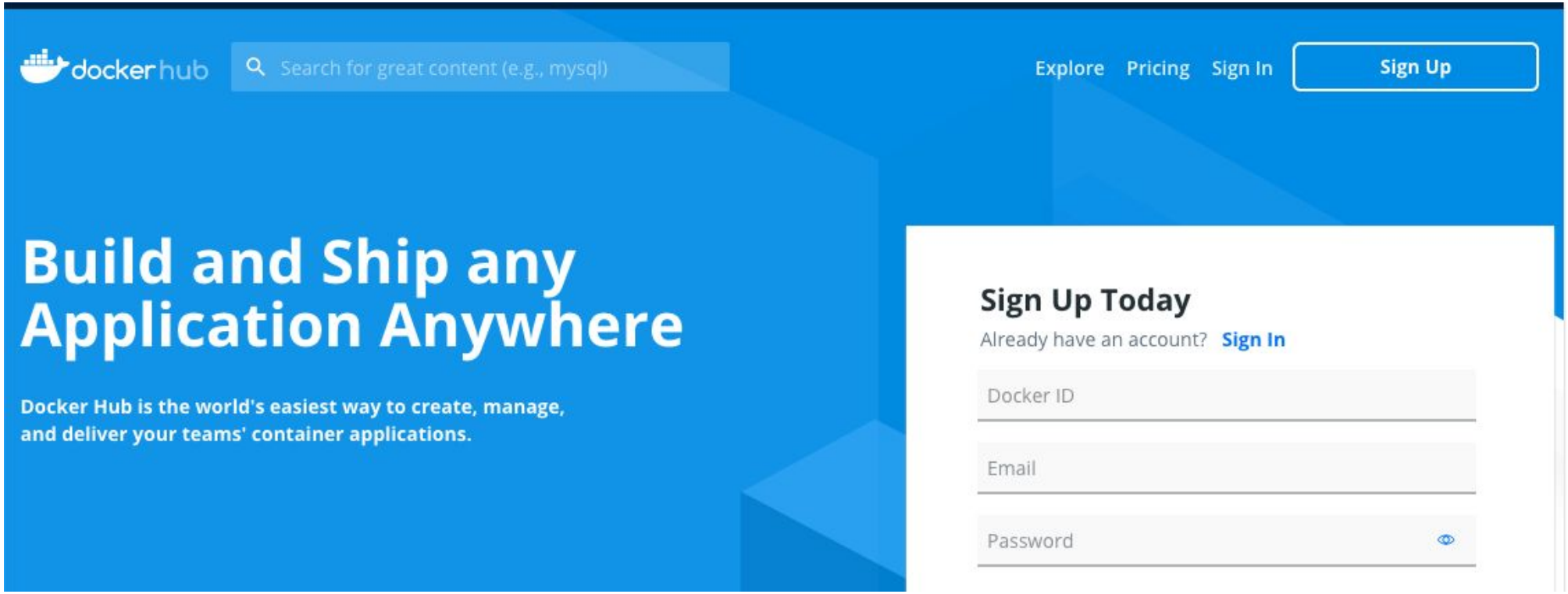
Experiment with Docker commands, such as:

- **docker ps**
  - List running containers
- **docker images**
  - List images
- **docker inspect docker/whalesay**
  - View data about the container
- **docker run -it docker/whalesay /bin/bash**
  - run bash to container
  - check the file /etc/os-release

Docker Exercise - step 3 of 7

Sign up for Docker Hub

https://hub.docker.com/



Docker Exercise - step 4 of 7

Build a Docker image and run a container.

Clone the simple-docker app repo

- git clone https://github.com/pontiggi/simple-docker
  (Exercise adapted from: https://github.com/docker/labs/blob/master/beginner/chapters/webapps.md)

In the same directory as “Dockerfile”, execute these commands:

- **docker build -t <DOCKER_HUB_USERNAME>/myfirstapp .**
  - Builds the image
  - The ‘-t’ flag tags the image with the name that follows.
  - The final ‘.’ means current directory.

- **docker run -p 8888:5000 --name myfirstapp <DOCKER_HUB_USERNAME>/myfirstapp**
  - Runs a container
  - The ‘-p’ flag binds the host port 8888 to the container’s port 5000.
  - The ‘--name’ (two dashes!) flag names the container.
  - <DOCKER_HUB_USERNAME>/myfirstapp is the name of the image to run.

Docker Exercise - step 5 of 7

Publish your image on Docker Hub

- **docker login**
  (Log into Docker Hub)

- **docker push <DOCKER_HUB_USERNAME>/myfirstapp**
  (Push your image to Docker Hub.)

Docker Exercise - step 6 of 7

Execute commands in a running container

- **docker exec -ti myfirstapp /bin/sh**

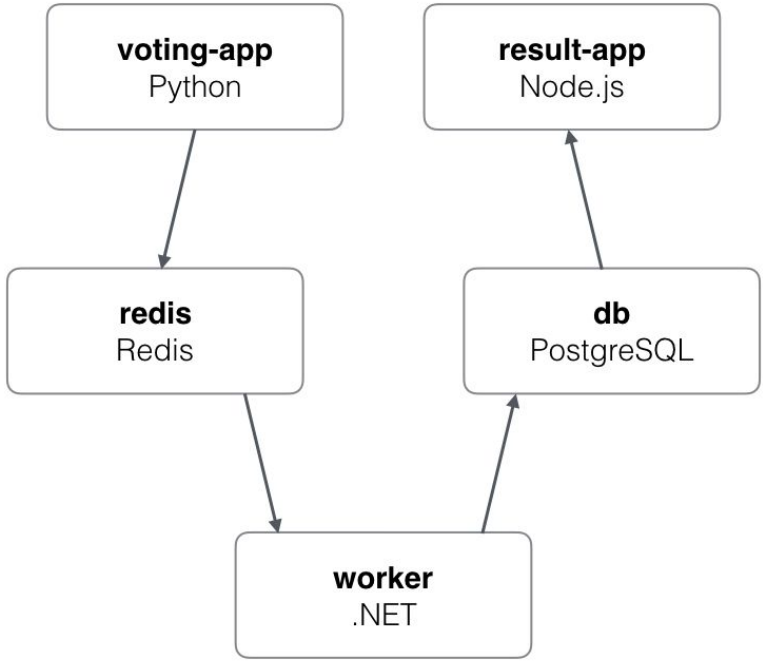
Stop and remove the container.

- **docker stop myfirstapp**
- **docker rm myfirstapp**

Docker Exercise - step 7 of 7

Explore a more complex project, where several components, one in each container, contribute to compose the whole application.

https://github.com/dockersamples/example-voting-app



Explore the file docker-compose.yml

```
$>  git clone https://github.com/dockersamples/example-voting-app
$>  cd example-voting-app
$>  docker compose up
```

http://localhost:5000
http://localhost:5001

Three takeaways

1. Container vs. image (writable package versus read-only snapshot)

2. Dockerfile works like a list of commands to make your environment.

3. Docker Documentation https://docs.docker.com/

Useful Resources

- Docker Documentation
- Dockerfile Best Practices
- Example Medium Article – “Intro to Docker for Front End Devs”
- Example Docker Command Cheat Sheet
- Push Your Project to a New GitHub Repo