Docker Tutorial

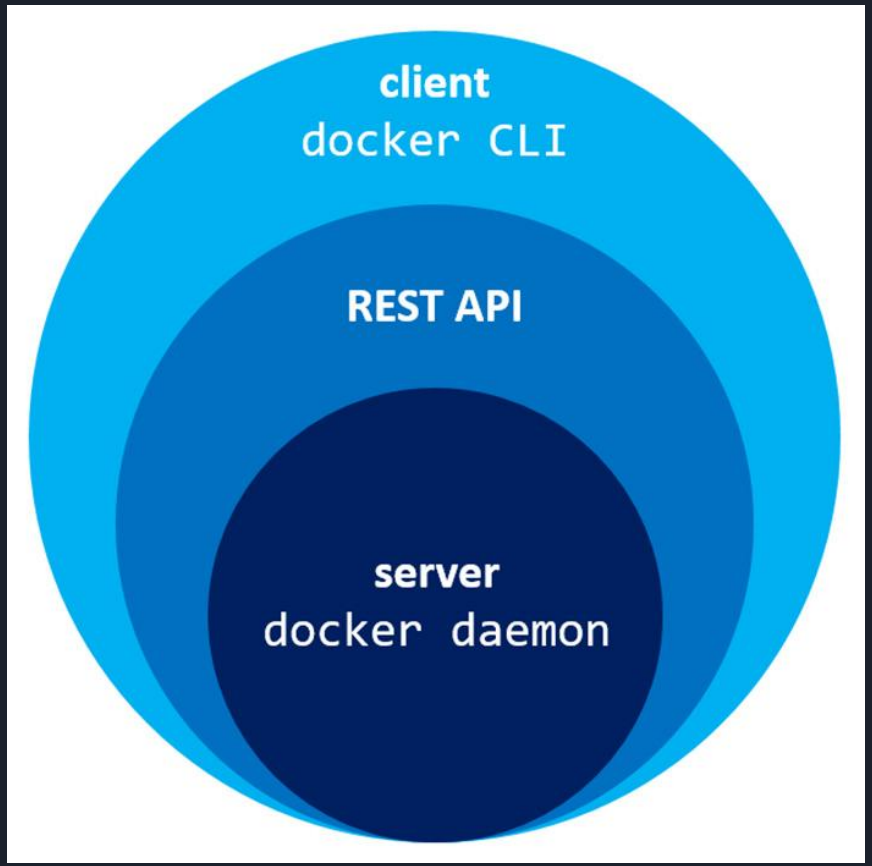
ECE 568: Engineering Robust Server Software

What is Docker?

Docker is a tool that makes it easier to create, run and deploy applications

Docker allows developers to package libraries, dependencies, and other necessary parts for an application and ship it all out as one package

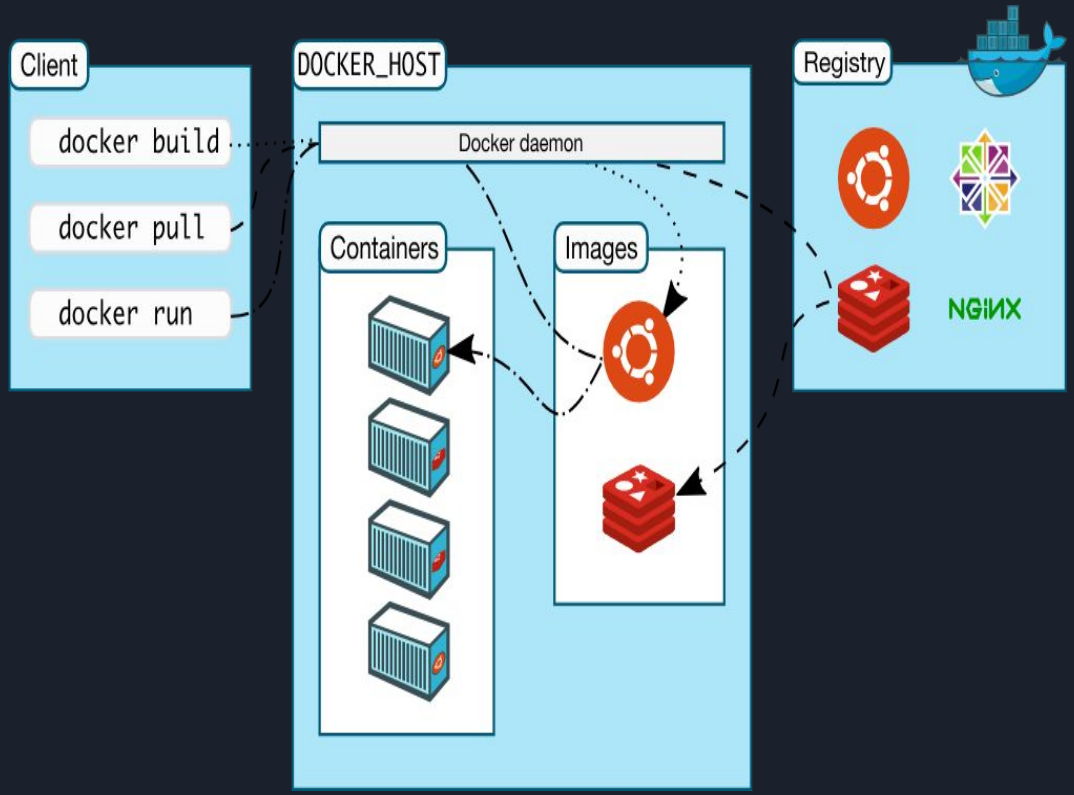
Docker Architecture



Docker Architecture

Docker is a client-server architecture

- Docker client (usually Docker CLI) talks to Docker daemon
- Docker registry stores images



What is a Dockerfile?

A Dockerfile is a text document that contains all the commands a user could call on the command line to assemble a Docker image

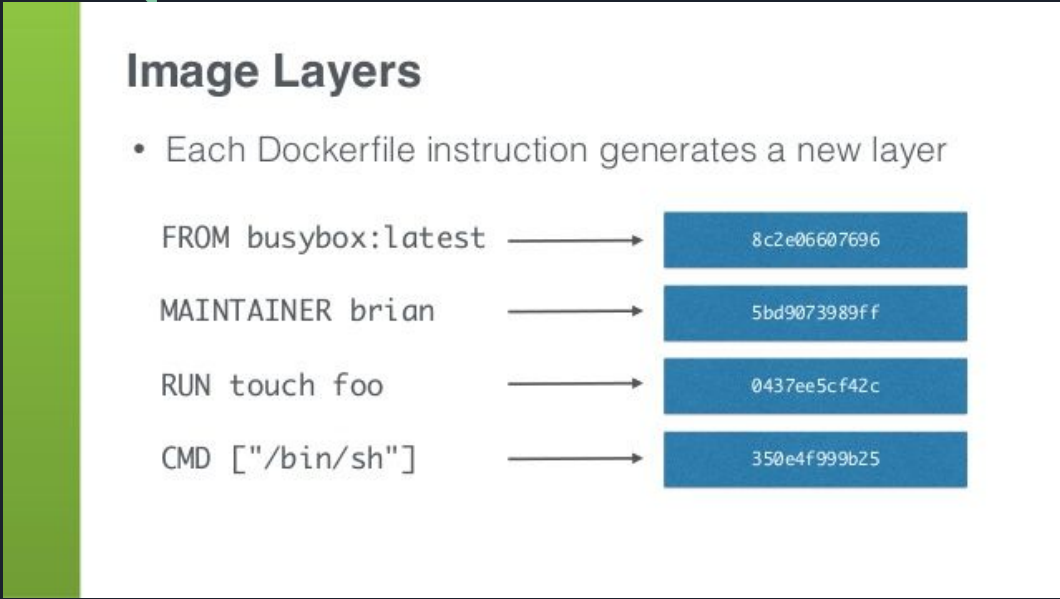
```
FROM ubuntu:15.04
COPY . /app
RUN make /app
CMD python /app/app.py
```

What is a Docker Image?

A Docker container **image** is a lightweight, standalone, executable package of software

- Use **build** command to create an image from a Dockerfile

Docker Image Layers



Docker images are built from a series of **layers**

- 1 layer/ instruction in Dockerfile
- Layers are essentially files generated from running a command in your Dockerfile
- Docker stores each layer on the host (for possible reuse later)

Docker Image Layers

```
FROM ubuntu
RUN apt-get update
RUN apt-get install -y apache2
RUN touch /opt/a.txt
```

```
$ docker history test/a
IMAGE          CREATED              CREATED BY                                      SIZE
4dc359259700   About a minute ago   /bin/sh -c touch /opt/a.txt                     8 B
9977b78fbad7   About a minute ago   /bin/sh -c apt-get install -y apache2           54.17 MB
e83b3bf07b42   2 minutes ago        /bin/sh -c apt-get update                       20.67 MB
9cd978db300e   3 months ago         /bin/sh -c #(nop) ADD precise.tar.xz in /       204.4 MB
6170bb7b0ad1   3 months ago         /bin/sh -c #(nop) MAINTAINER Tianon Gravi <ad   0 B
511136ea3c5a   10 months ago                                                        0 B
```

Docker Image Layers

```
FROM ubuntu
RUN apt-get update
RUN apt-get install -y apache2
RUN touch /opt/b.txt
```

```
$ docker history test/b
IMAGE          CREATED              CREATED BY                                      SIZE
c0daf4be2ed4   42 seconds ago       /bin/sh -c touch /opt/b.txt                     8 B
9977b78fbad7   About a minute ago   /bin/sh -c apt-get install -y apache2           54.17 MB
e83b3bf07b42   3 minutes ago        /bin/sh -c apt-get update                       20.67 MB
9cd978db300e   3 months ago         /bin/sh -c #(nop) ADD precise.tar.xz in /       204.4 MB
6170bb7b0ad1   3 months ago         /bin/sh -c #(nop) MAINTAINER Tianon Gravi <ad   0 B
511136ea3c5a   10 months ago                                                        0 B
```

DockerHub Images

Repository of public images developers can use

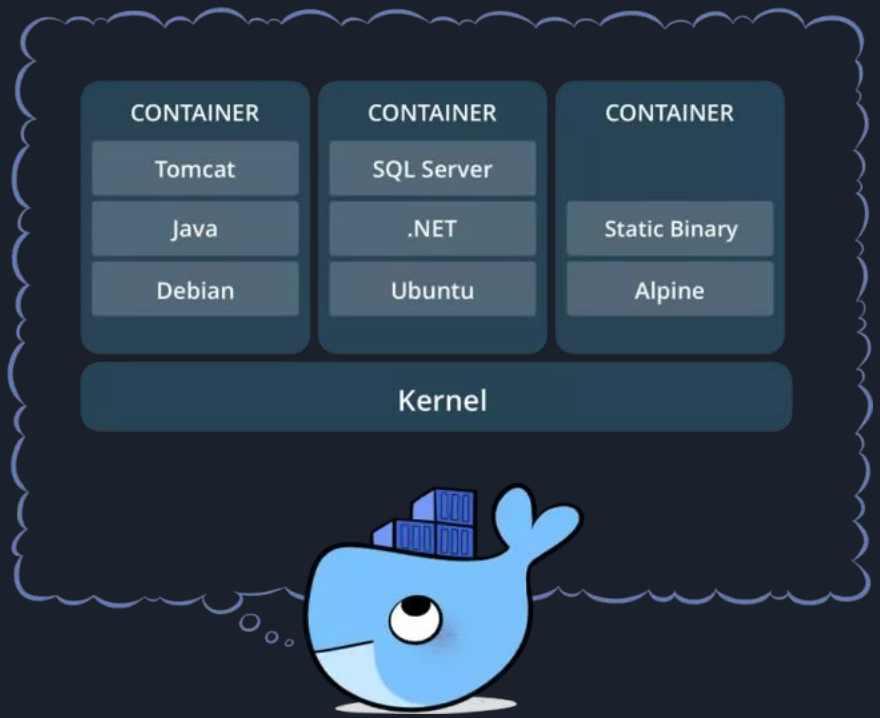
Stable open-source images available to the public

What is a Docker Container?

If an image is a class, a container is an **instance** of the class → a runtime object

Containers are portable encapsulations of an environment to run an application

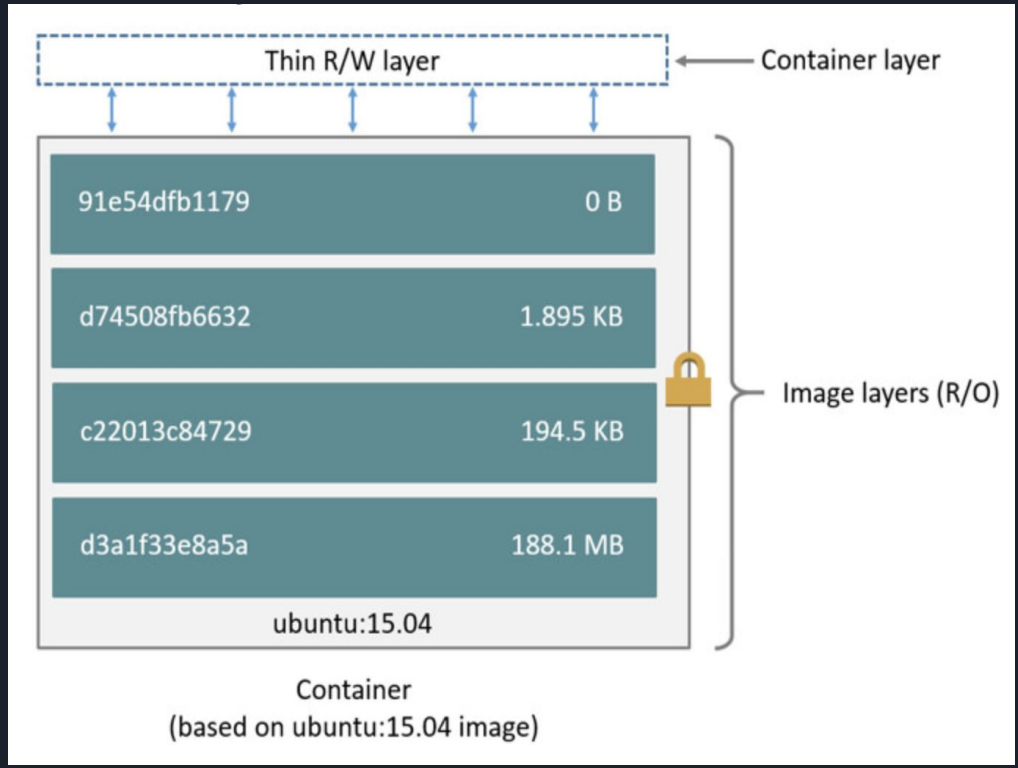
These containers are **not static** and can actually be written to



Docker Images vs Containers

The difference between a container and an image is the **top writable layer**

- Any writes to a container occur here
- can base multiple containers off same image (each container has own writable layer/unique data state)



What is a Data Volume?

A data volume is a specially designed directory in the container

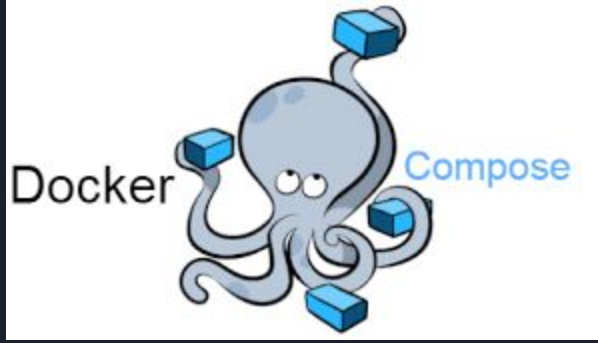
Main Uses:

- Persistent storage of data
- Mounting host directories

Building Your Own Docker Image

```
FROM python:3
ENV PYTHONUNBUFFERED 1
RUN mkdir /code
WORKDIR /code
ADD requirements.txt /code/
RUN pip install -r requirements.txt
ADD . /code/
```

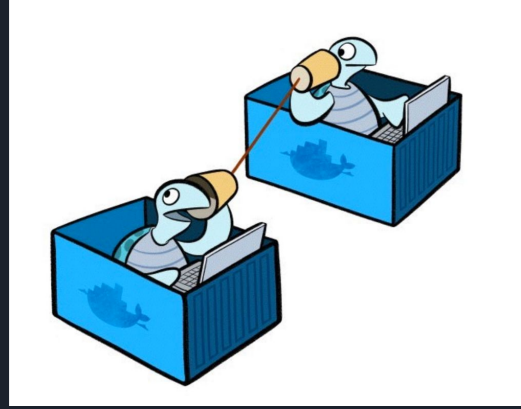
What is Docker Compose?



Docker Compose is a tool for defining and running multi-container Docker applications

- Defined YAML file

Docker Container Networking



With multiple containers, a layer of networking is needed for communication (between each other and to the outside world)

Docker supports multiple network drivers but the most commonly used one (and the one we'll use here) is the **bridge network (docker0)**

Need to specify ports for containers to use to communicate between containers or from each container to the outside world

Using Docker Compose

```
version: '2'

services:
  db:
      image: postgres
  web:
      build: ./web-app
      user: nobody
      command: bash -c "python3 manage.py makemigrations && python3
      manage.py migrate && python3 manage.py runserver 0.0.0.0:8000"
      volumes:
        - ./web-app:/code
      expose:
        - "8000"
      depends_on:
        - db
  nginx:
     image: nginx:latest
     ports:
       - "8000:8000"
     volumes:
       - ./nginx/config:/etc/nginx/conf.d
     depends_on:
       - web
```

Using Docker Compose (2nd File)

```
version: '2'

services:
  db:
      image: postgres
      volumes:
            - data-volume:/var/lib/postgresql/data
  web-init:
      build: ./web-app
      command: /code/initserver.sh
      volumes:
        - ./web-app:/code
      depends_on:
        - db
  web:
      build: ./web-app
      user: nobody
      command: /code/runserver.sh
      volumes:
        - ./web-app:/code
      expose:
        - "8000"
      depends_on:
        - web-init
  nginx:
     image: nginx:latest
     ports:
       - "8000:8000"
     volumes:
       - ./nginx/config:/etc/nginx/conf.d
     depends_on:
       - web
volumes:
   data-volume:
```

Command Scripts

```
#!/bin/bash
python3 manage.py makemigrations
python3 manage.py migrate
res="$?"
while [ "$res" != "0" ]
do
    sleep 3;
    python3 manage.py migrate
    res="$?"
done
```

Command Scripts

```
#!/bin/bash
while [ "1"=="1" ]
do
    python3 manage.py runserver 0.0.0.0:8000
    sleep 1
done
```

Useful References

https://rominirani.com/docker-tutorial-series-a7e6ff90a023

https://docs.docker.com/v17.09/engine/userguide/storagedriver/imagesandcontainers/

https://nickjanetakis.com/blog/differences-between-a-dockerfile-docker-image-and-docker-container

https://docs.docker.com/compose/django/

https://thenewstack.io/container-networking-breakdown-explanation-analysis/

https://www.aquasec.com/wiki/display/containers/Docker+Networking+101

https://www.infoworld.com/article/3077875/linux/containers-101-docker-fundamentals.html