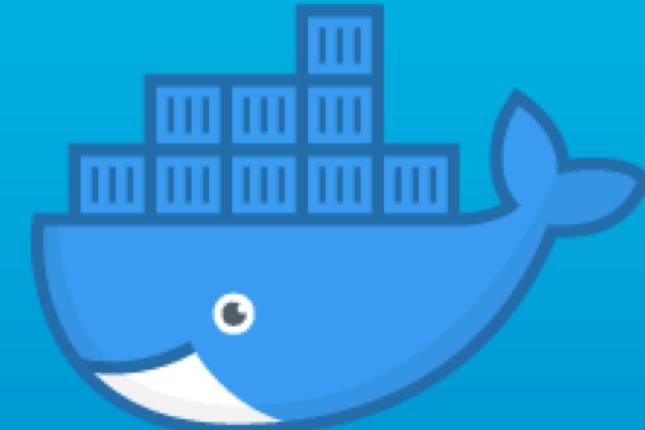


Docker basics

Andrea Panizza



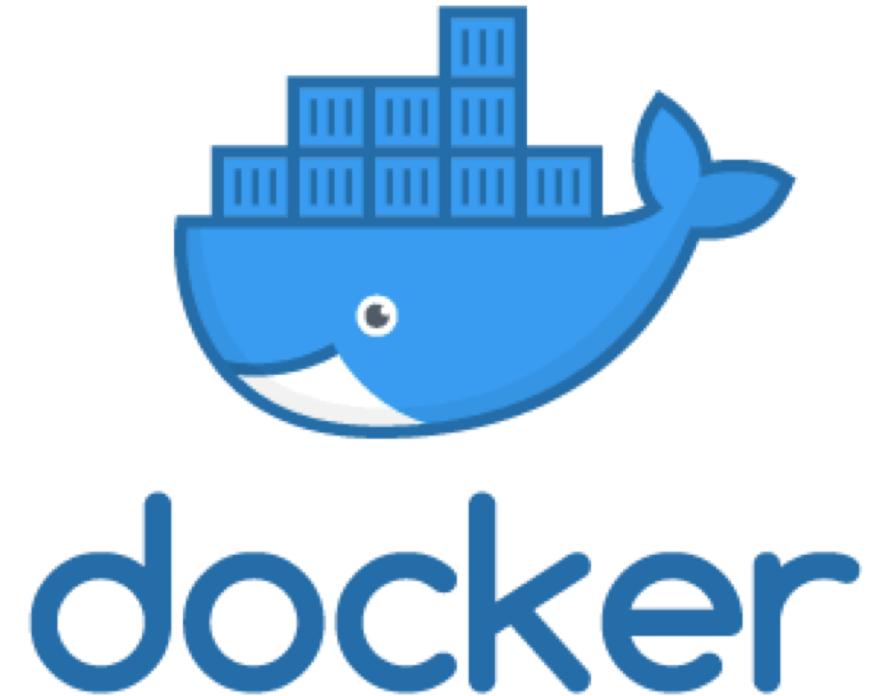
October 7, 2019



docker

Contents

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$ docker --deep-learning  
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docker why

- Choose an OS
- Install CUDA and CuDNN
- Install python (2.7? 3.5? 3.8?) & libraries
- Install tensorflow
- TF & CUDA versions not compatible
- Expose ports
- Possible conflicts
- Breaking updates
- Different OS/libraries in Dev/Prod
- Ok, but now it doesn't scale
- HEEEEELLLLPP!!!!!!



- Install Docker
- Write a Dockerfile
- docker build
- docker run
-



docker why

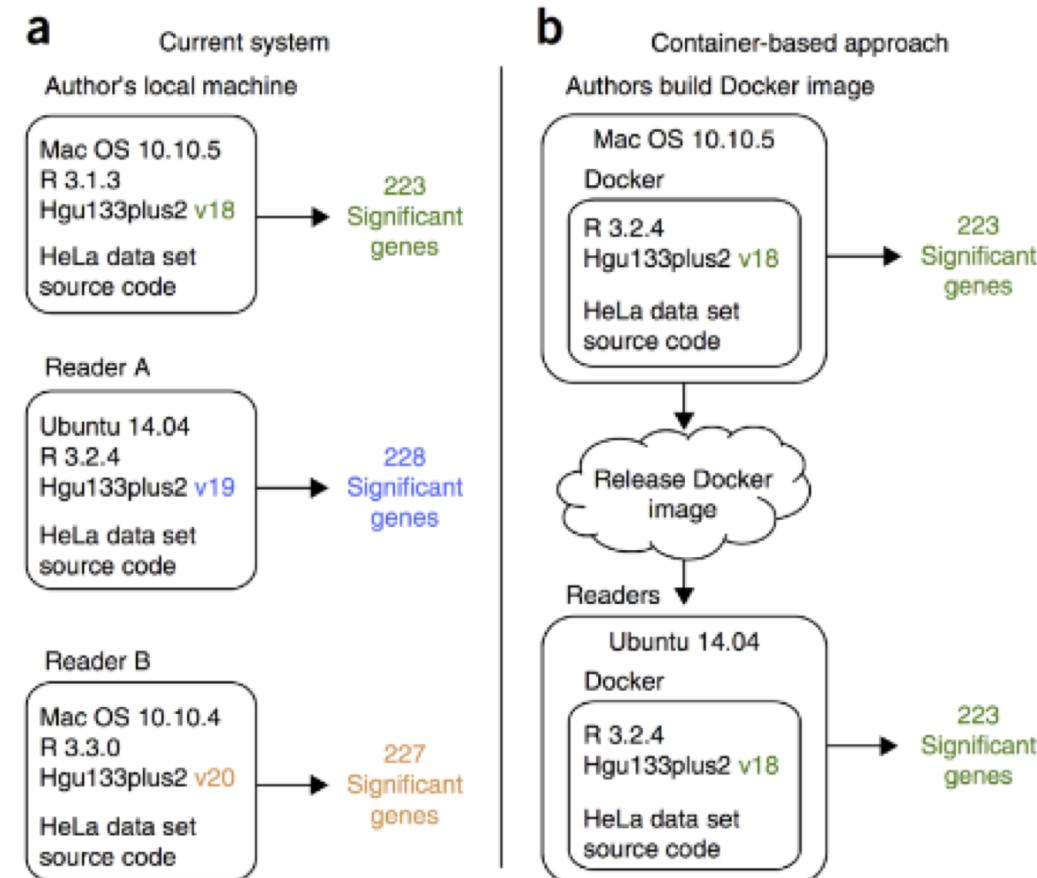
A true story

nature
biotechnology

Reproducibility of computational workflows is automated using continuous analysis

Brett K Beaulieu-Jones¹ & Casey S Greene²

Beaulieu-Jones & Greene
(2017) doi:10.1038/nbt.3780



docker why

Q: isn't this solved by
venv/pipenv/conda/
etc.?

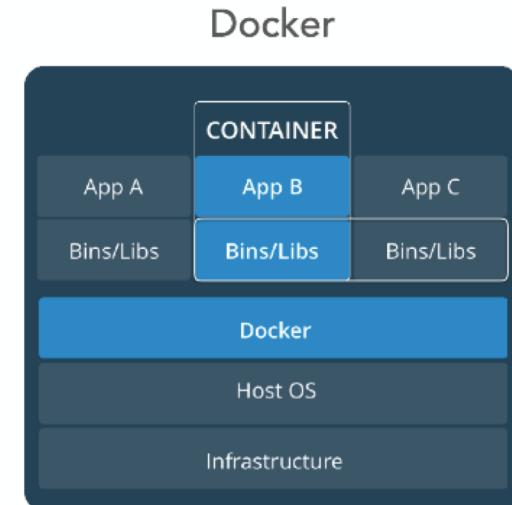
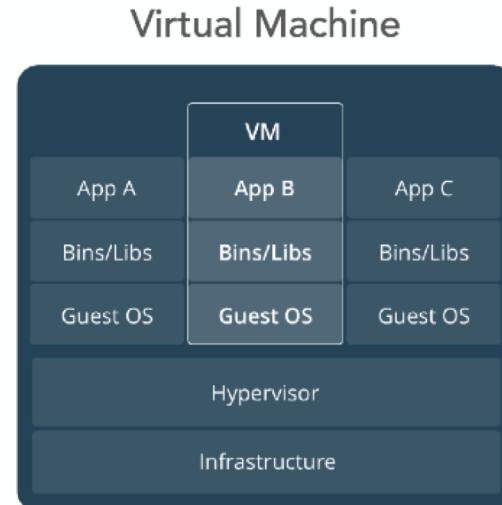
A: Nope!

- `venv` & `pipenv` only deal with Python packages dependencies. For anything else (e.g., Python version, CUDA, `libglib2.0-0`, etc.) you're pretty much f*ck*d. Also, a virtual environment is not really self-contained: some Python packages install stuff outside the virtual env dir.
- `conda` can manage environments for other languages other than Python, but it still doesn't manage the other dependencies
- None of these approaches guarantees complete isolation and seamless transferability across different environments. **You will all have experiences of `conda/venv` crashing after some admin change on your machines!**

docker what

virtual machines solve the **dependency** issue...

...but they're very resource-intensive (**scalability**). We need a lighter framework



docker what

Docker containers are:

- Cheaper
- Less computational overhead
- Trendy
- Made to crash and be restarted
- Scaling and coordinating is easy
- **Develop code in your preferred environment, run anywhere**



docker what

Docker containers are **not** virtual machines:

- “VMs are like houses, each is a single unit w/ standalone plumbing and wiring. Containers are like apartments; each one is a unit (process) in a host (building), sharing the plumbing and wiring w/ one another as well as the rest of the building” (Mike Coleman - Technology Evangelist, Docker)

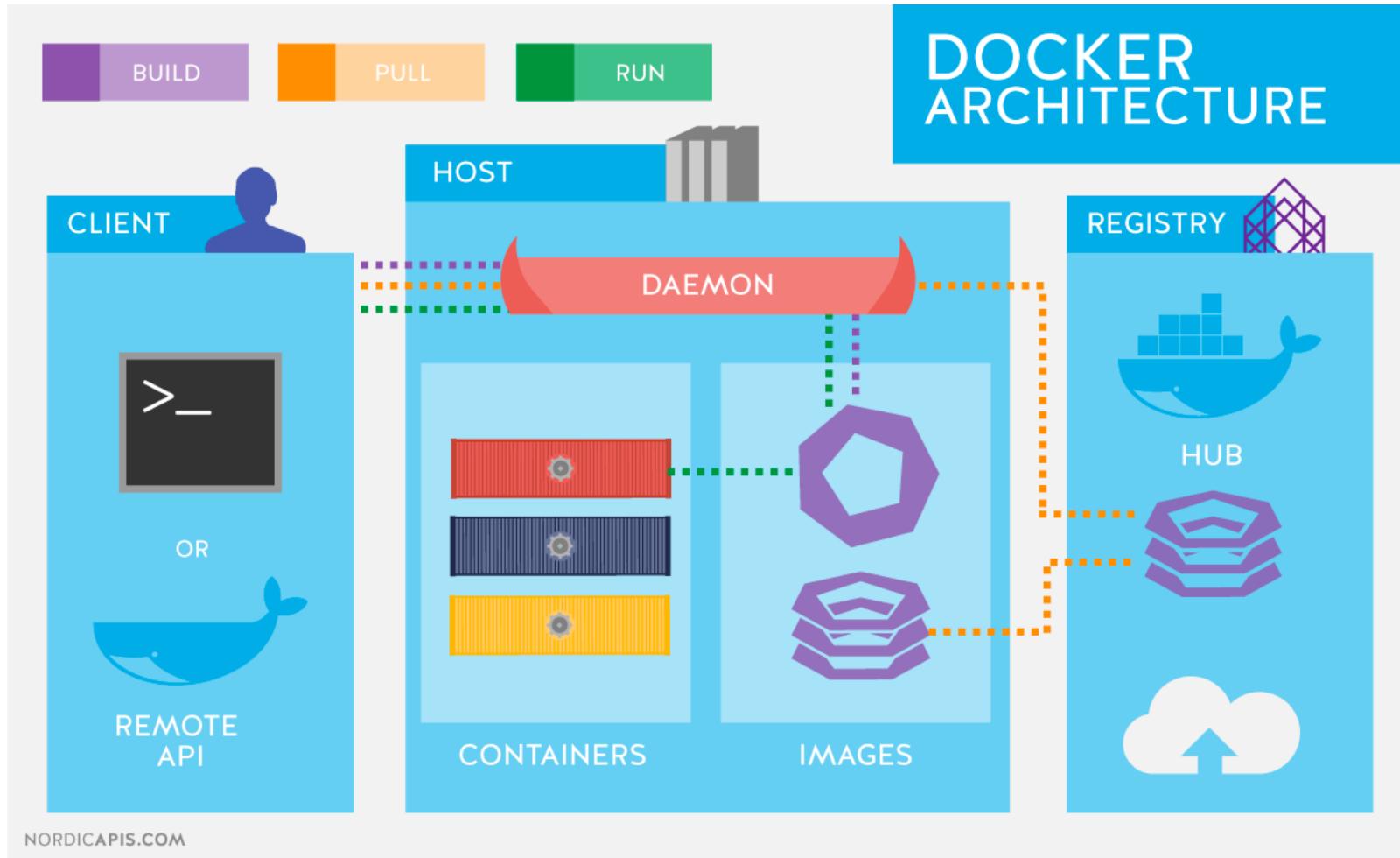


docker vocabulary

image	package defining a working environment (binary file)
container	a running instance of an image (process)
Dockerfile	text file containing commands to build an image
Docker Hub	A website/repository for sharing Docker images
Docker client	sends CLI commands to Docker daemon through Docker REST API (process)
Docker daemon	executes calls from Docker client

Docker native client/server architecture
makes it easy to design web services

docker architecture



docker how

- Define an image by writing a Dockerfile
- **FROM**: initialize a new build stage & set base image. A valid Dockerfile **must** start with **FROM**.
- **LABEL**: add metadata to an image (key/value pair). A typical key is **maintainer**
- **COPY**: copy files/folders from <src> and add to container filesystem at path <dest>
- **RUN**: execute commands in a new layer on top of the current image and commit results
- **WORKDIR**: set working directory for any command which follows
- **CMD**: defaults for the container execution

```
FROM tensorflow/tensorflow:1.13.1-py3-jupyter

LABEL maintainer="youremail@here.com"

RUN apt-get -y update -o Acquire::https::Verify-Peer=false \
&& apt-get -y install --no-install-recommends \
libglib2.0-0 \
libsmb6 \
libxext6 \
libxrender \
git \
&& rm -rf /var/lib/apt/lists/*

WORKDIR /

ENV PATH="${PATH}:/root/.local/bin"

COPY requirements.txt /

RUN pip3 install --user --upgrade -r /requirements.txt

RUN git clone https://github.com/fizyr/keras-retinanet.git

RUN cd keras-retinanet && \
    pip3 install --user .

RUN pip3 install --user git+https://github.com/cocodataset/cocoapi.git#subdirectory=PythonAPI

COPY Container-Root /

CMD ./startup.sh
```

docker how

To build the image, from the Dockerfile directory run

`docker build [BUILD_OPTS] -t IMAGE:[TAG]` (tip: **always** name & tag your images)

Docker downloads the base image from the Web (if it didn't do it before) and starts building. After building, to run the container, in any directory run

`docker run [OPTIONS] IMAGE[:TAG|@DIGEST] [COMMAND] [ARG...]`

(can be complicated...but see later!)

Each container is an instance of an image: you can run multiple (containers) instances based on the same image, as long as each has a unique name.

Containers are stateless and immutable: once a container completes execution, all its content is lost, and any other container started from the same image doesn't inherit any state from the first one (**reproducibility**).

Mapping local folders

All content from a Docker container is lost, once it terminates execution. In order to export content from it, we **map** a folder on the host filesystem, to a folder in the Docker container filesystem. Example:

```
docker run -v /home/andrea/docker_test:/test -it ubuntu /bin/bash
```

maps the folder `docker_test` on the host system to the folder `/test` in the Docker container, starts a container based on the `ubuntu` image in interactive mode and drops you in the `bash` shell.

`depend --on-docker`

[Depend On Docker](#) is a framework developed at BHGE Digital which helps building, shipping & running applications with Docker.



docker --deep-learning

- Let's build a simple image and make some practice with Depend on Docker
- We will create an image to run two models in Jupyter:
 - a pre-trained ResNet-50 model (uses default Keras implementation)
 - a pre-trained RetinaNet model (uses <https://github.com/fizyr/keras-retinanet/>)

```
git clone https://github.com/AndreaPi/docker-training-2019-public.git
```

Manage images/containers

docker images -aq

docker ps -a

docker rm <container-ID>

docker rm \$(docker ps -aq)

docker rmi <image-ID>

docker rmi \$(docker images -aq)

docker run --rm --it --name cntr myimage

List all images

List all containers: you need to remove containers before you can remove images
remove container

remove all containers

remove image

Remove all images

run container with name **cntr**, from image *myimage*, in interactive (*it*) mode and remove (*rm*) container after you exit:
great to avoid having many hanging containers

A few extra tips on writing Dockerfiles

Order matters for caching

```
FROM debian
COPY . /app
RUN apt-get update
RUN apt-get -y install openjdk-8-jdk ssh vim
COPY . /app
CMD ["java", "-jar", "/app/target/app.jar"]
```

Order from least to most frequently changing content.

More specific COPY to limit cache busts

```
FROM debian
RUN apt-get update
RUN apt-get -y install openjdk-8-jdk ssh vim
COPY . /app
COPY target/app.jar /app
CMD ["java", "-jar", "/app/target/app.jar"]
```

Only copy what's needed. Avoid "COPY ." if possible

Line buddies: apt-get update & install

```
FROM debian
RUN apt-get update
RUN apt-get -y install openjdk-8-jdk ssh vim
RUN apt-get update \
&& apt-get -y install \
    openjdk-8-jdk ssh vim
COPY target/app.jar /app
CMD ["java", "-jar", "/app/app.jar"]
```

Prevents using an outdated package cache

Remove unnecessary dependencies

```
FROM debian
RUN apt-get update \
&& apt-get -y install --no-install-recommends \
    openjdk-8-jdk ssh vim
COPY target/app.jar /app
CMD ["java", "-jar", "/app/app.jar"]
```

A few extra tips on writing Dockerfiles

Remove package manager cache

```
FROM debian
RUN apt-get update \
&& apt-get -y install --no-install-recommends \
openjdk-8-jdk \
&& rm -rf /var/lib/apt/lists/*
COPY target/app.jar /app
CMD ["java", "-jar", "/app/app.jar"]
```

Use official images when possible

```
FROM debian
RUN apt-get update \
&& apt-get -y install --no-install-recommends \
openjdk-8-jdk \
&& rm -rf /var/lib/apt/lists/*
FROM openjdk
COPY target/app.jar /app
CMD ["java", "-jar", "/app/app.jar"]
```

Use more specific tags

```
FROM openjdk:latest
FROM openjdk:8
COPY target/app.jar /app
CMD ["java", "-jar", "/app/app.jar"]
```

- The Docker blog post lists even more best practices which you may want to learn and use!

The "latest" tag is a rolling tag. Be specific, to prevent unexpected changes in your base image.

docker resources

- [the official Docker cheatsheet](#)
- [Another cheatsheet](#)
- [Yet another one](#)
- [Some Docker notes](#)
- <https://docs.docker.com/engine/reference/builder/>
- [https://docs.docker.com/develop/develop-images/dockerfile best-practices](https://docs.docker.com/develop/develop-images/dockerfile_best-practices/)
- <https://blog.docker.com/2019/07/intro-guide-to-dockerfile-best-practices/>