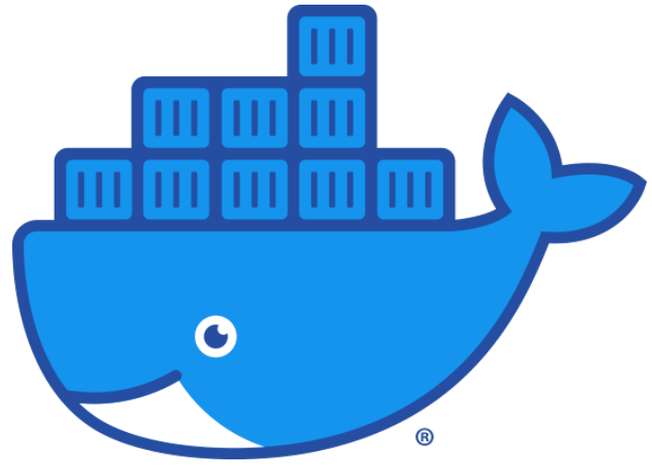
[544] Docker Deployment

Tyler Caraza-Harter



Outline

Virtualization

Images, Containers, and Dockerfiles

Ports

Docker Compose

What is virtualization?

Definition: the illusion of **private** resources, provided by software

Contexts this semester

- Virtual Memory
- Virtual Machines (hardware)
- Virtual Machines (languages)
- Virtual Operating System (container) *new today*

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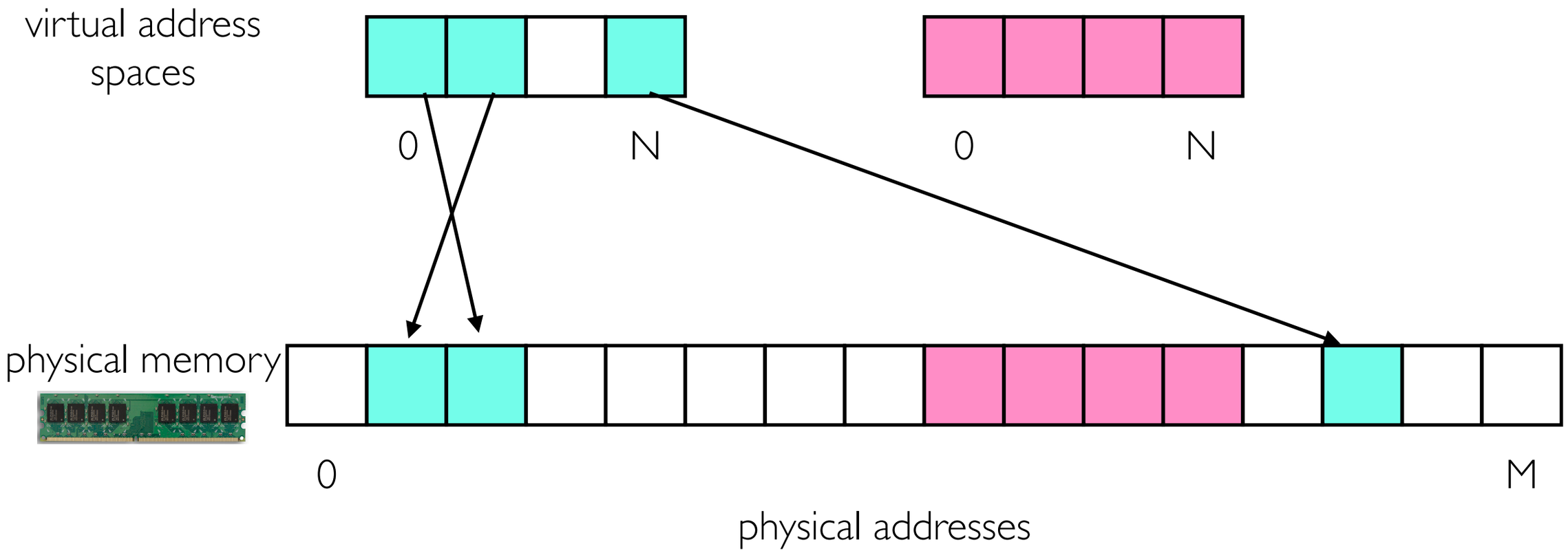
each process using a virtual address space
isn't aware of other processes using memory
(illusion of private memory)



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virtualized resources include CPU, RAM, disks, network devices, etc

VMs rarely use all their allocated resources, so overbooking is possible

VM: 8 GB of RAM and 4 cores

VM: 6 GB of RAM and 3 cores

VM: 8 GB of RAM and 6 cores

virtual machines for rent (by you)

Physical Machine: 16 GB of RAM and 8 CPU cores

actual hardware bought by Google for their cloud services (GCP)

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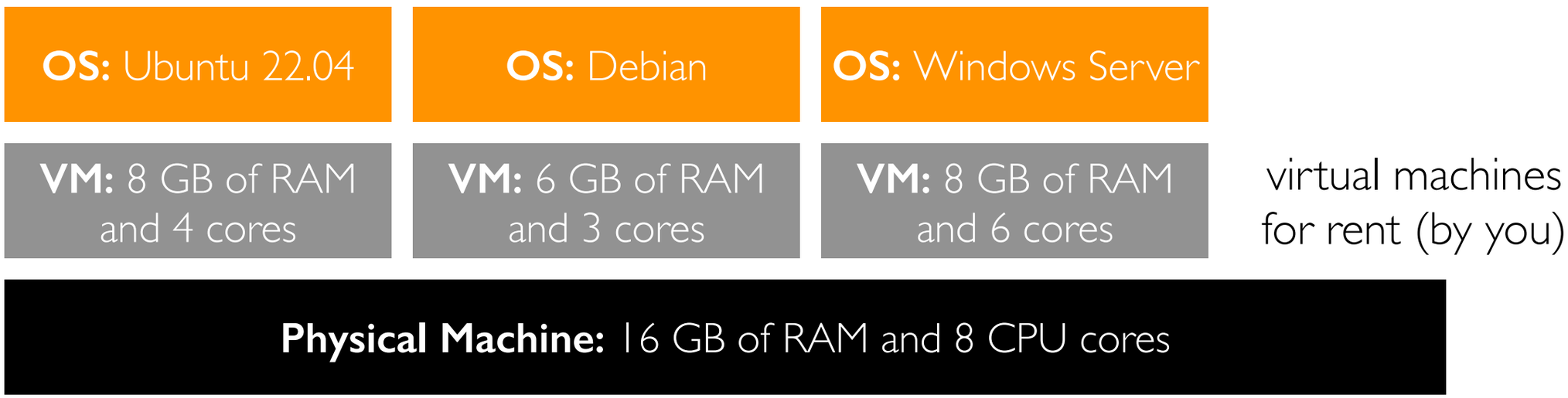
problem: if each program is deployed to a different VM, operating system overheads will dominate

these operating systems are mostly unaware that their on VMs instead of physical hardware



virtual machines for rent (by you)

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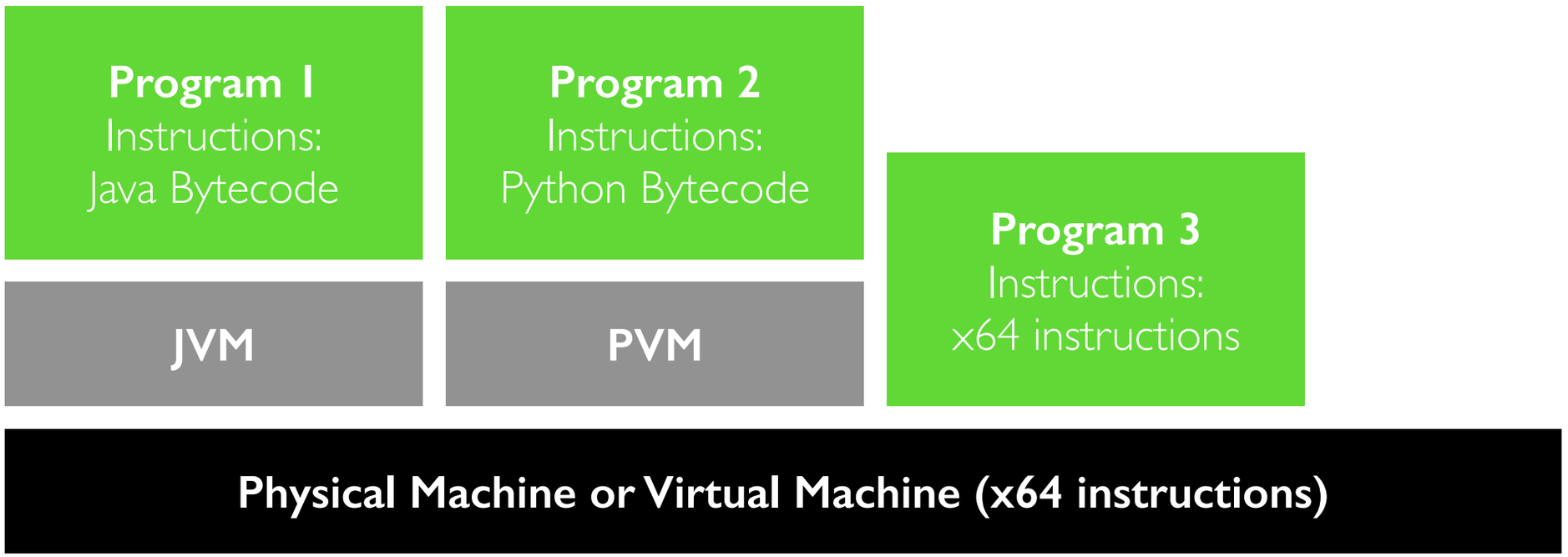

actual hardware bought by Google for their cloud services (GCP)

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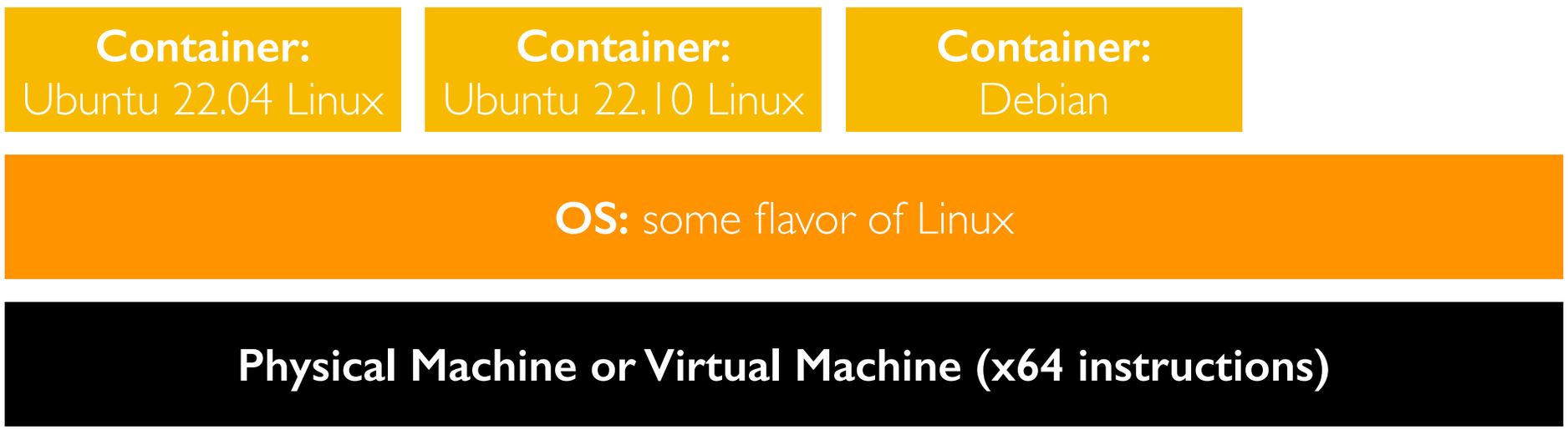
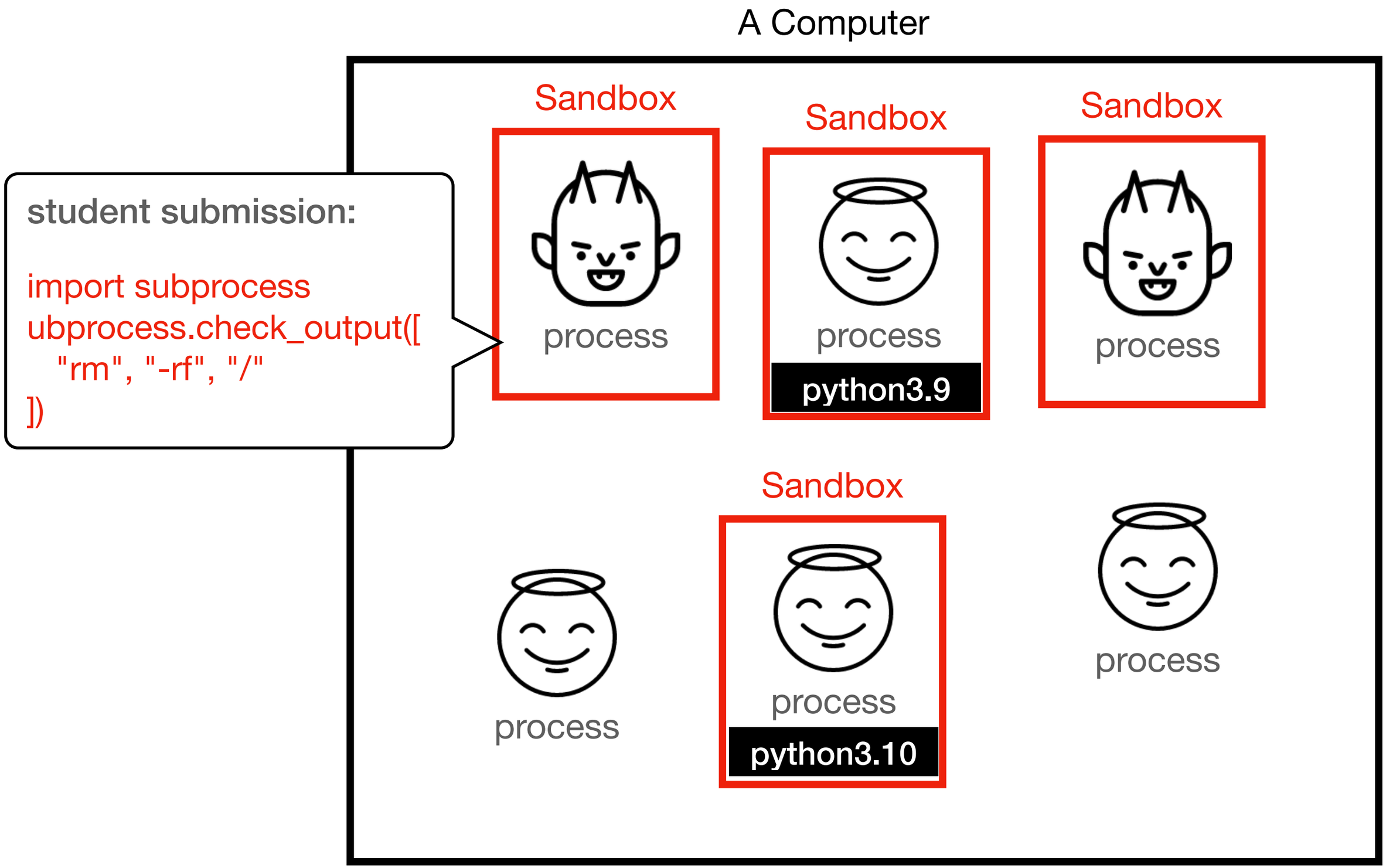
Linux containers

- Docker makes creation easy
- The "physical" OS is shared, which is very efficient
- Programs in different containers can uses different flavors of Linux
- Cannot have a Windows container on Linux



actual hardware bought by Google for their cloud services (GCP)

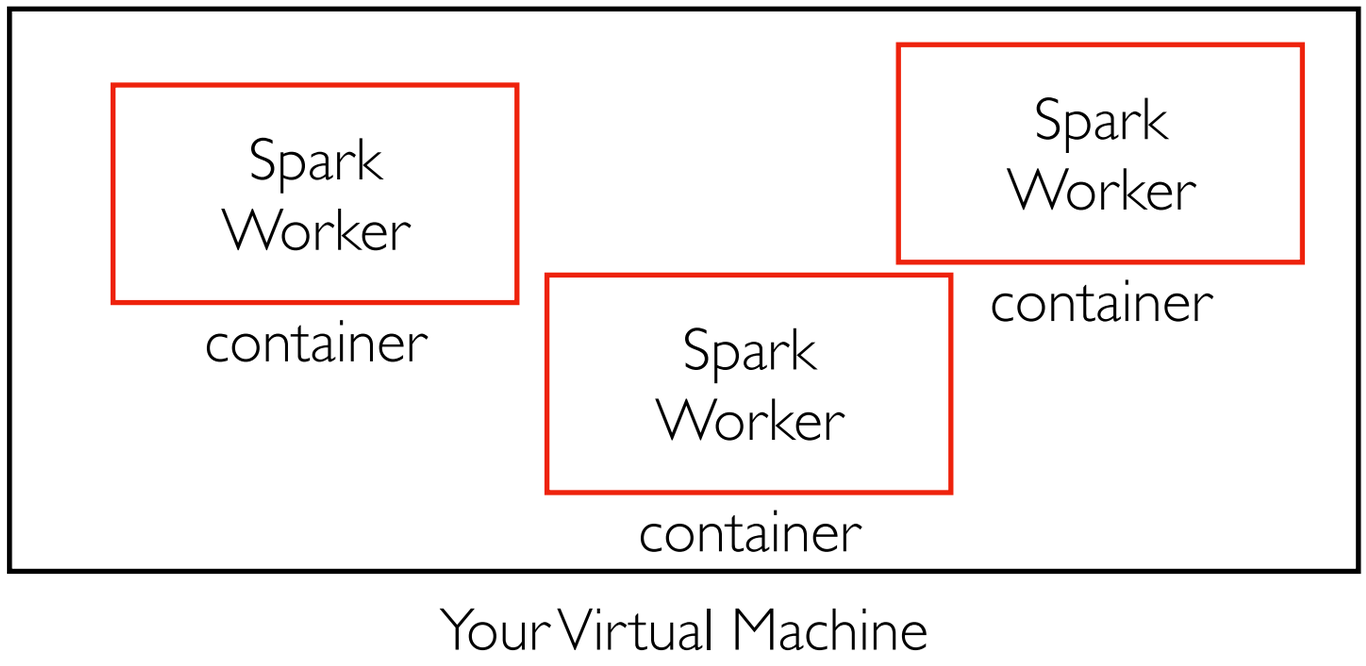
Containers and Virtual Machines are "Sandboxes"



Docker containers

Containers are a lightweight alternative to virtual machines.

You'll run Docker containers this semester to have your own "mini cluster"



Resources of the "cluster" are limited to those of a single VM, so we'll scale projects accordingly. But the techniques will apply to large clusters and datasets.

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TIP: make notes of docker commands

docker **SOME-COMMAND** arg1, arg2, ...

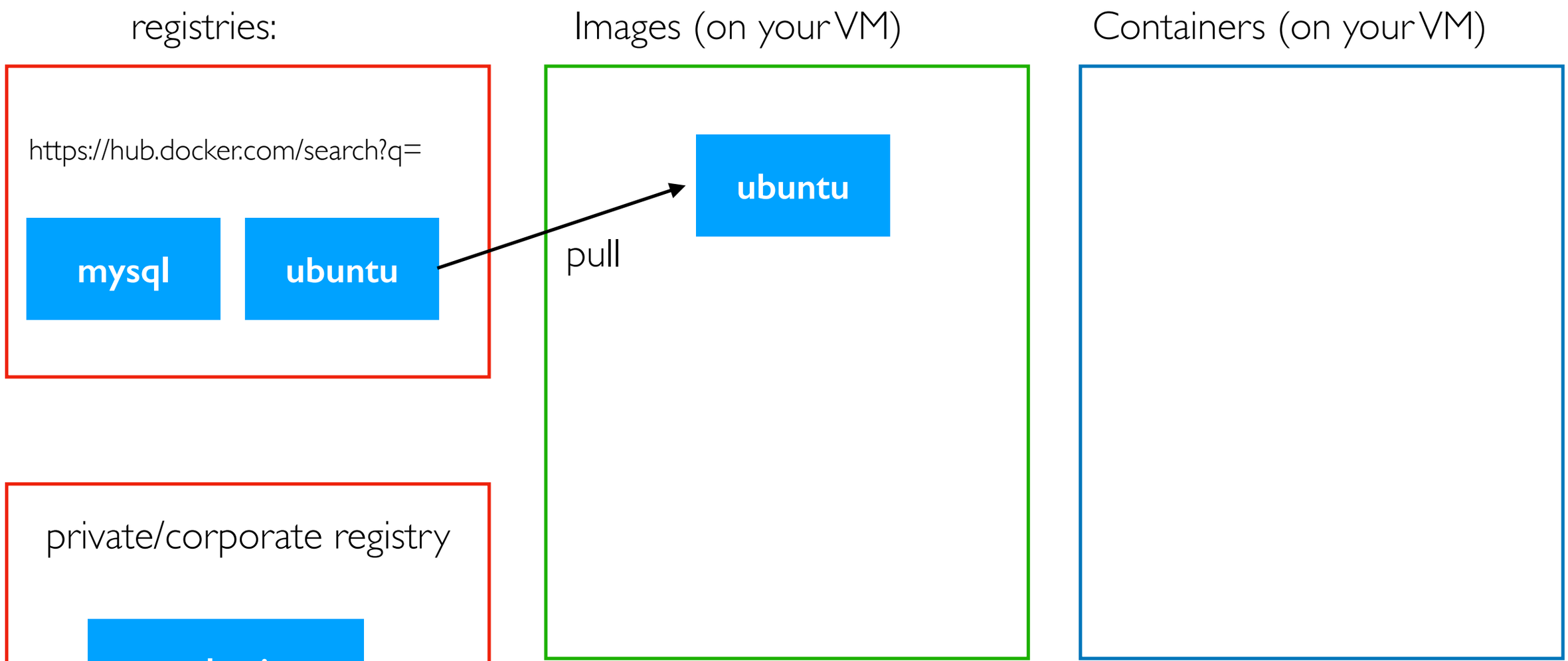
Docker Install

For Ubuntu 22.04:

```
sudo snap install docker

# allow regular user to use docker
sudo groupadd docker
sudo usermod -aG docker $USER
sudo chgrp docker /var/run/docker.sock
```

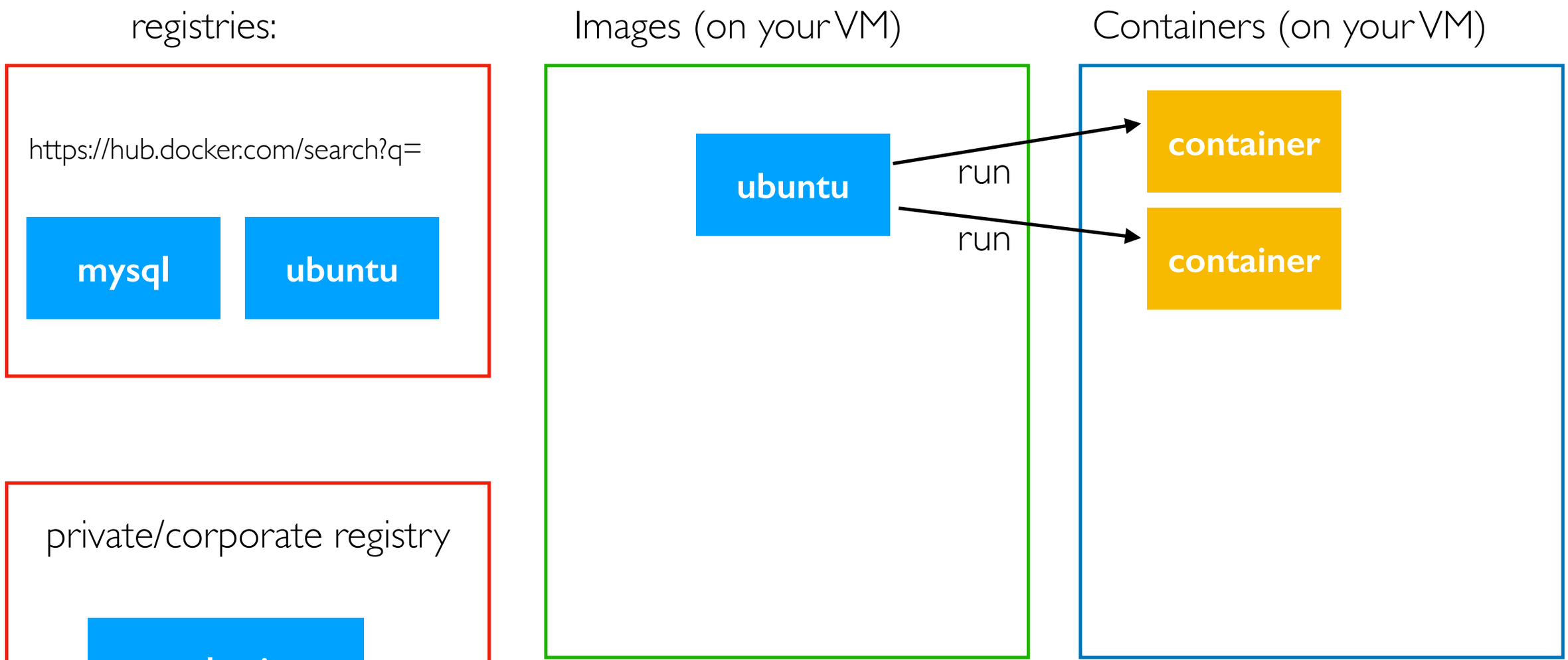
Registries, Images, Containers, and Dockerfiles



Images

- snapshot of installed software from which to create a container
- docker **pull** ubuntu:22.04

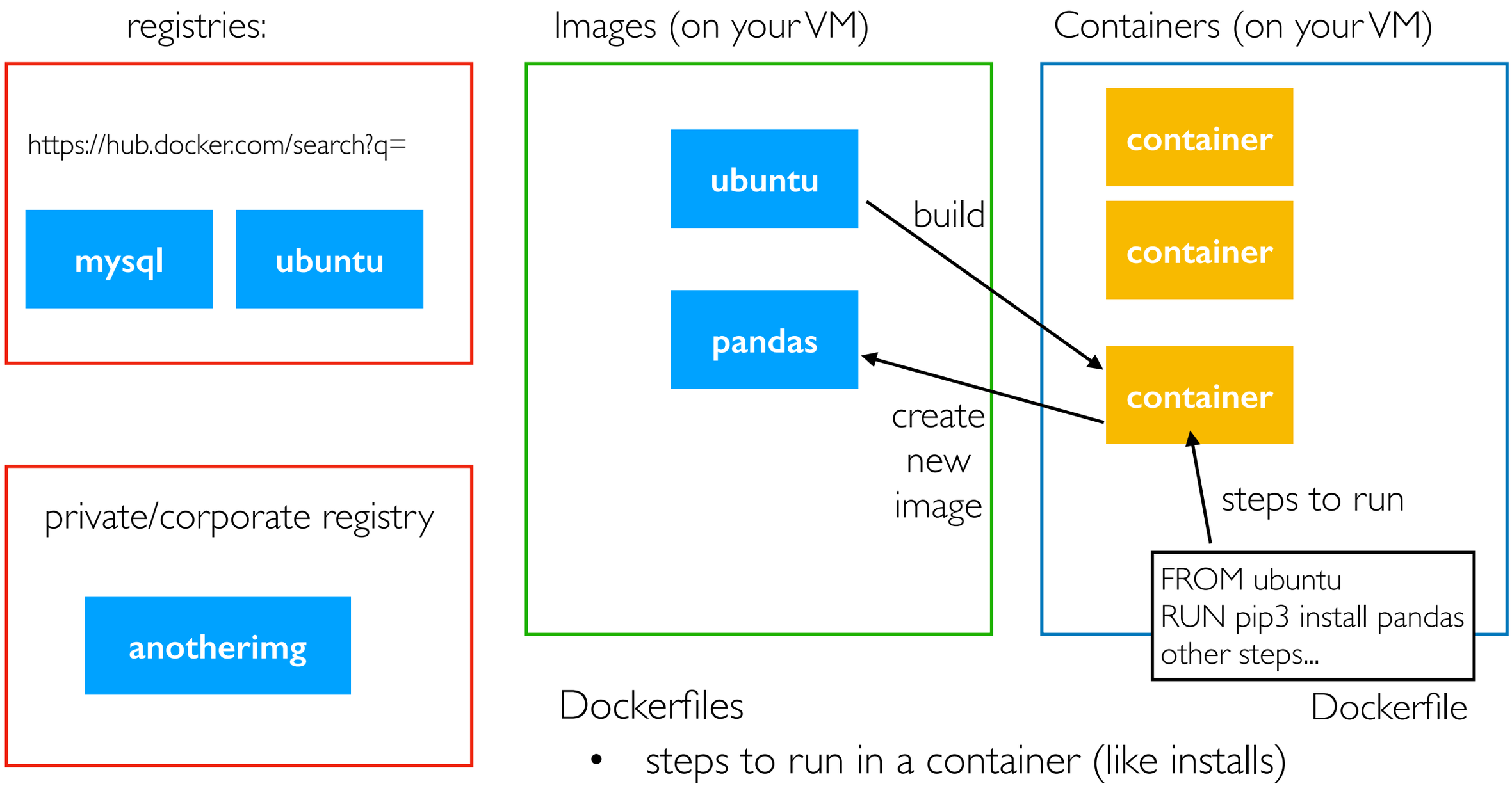
Registries, Images, Containers, and Dockerfiles



Containers

- Linux sandbox in which to run processes
- docker **run** ubuntu

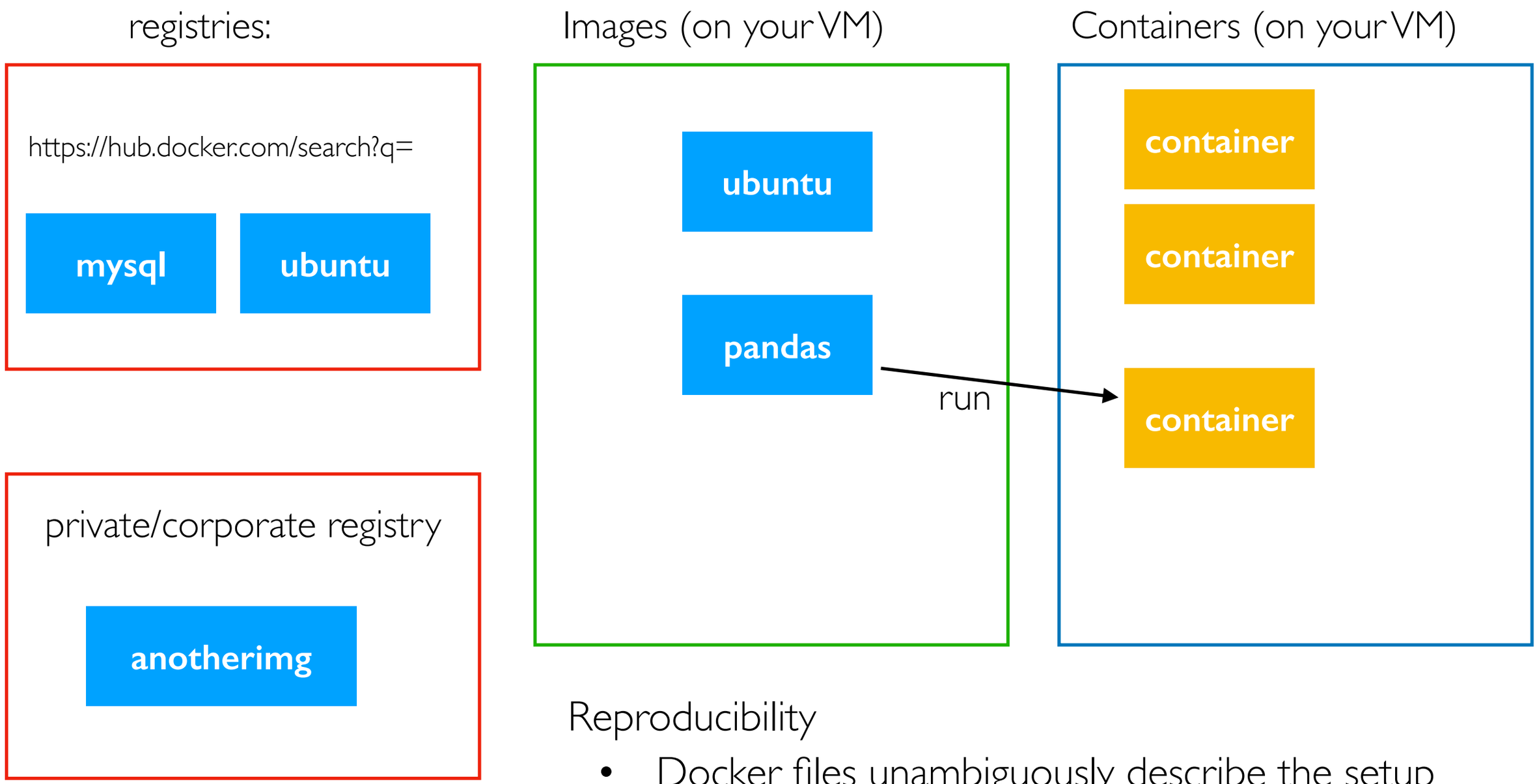
Registries, Images, Containers, and Dockerfiles



Dockerfiles

- steps to run in a container (like installs)
- creates a new image
- docker **build** myimg -t pandas

Registries, Images, Containers, and Dockerfiles



Reproducibility

- Docker files unambiguously describe the setup
- Others can get all the same version numbers

Demos...

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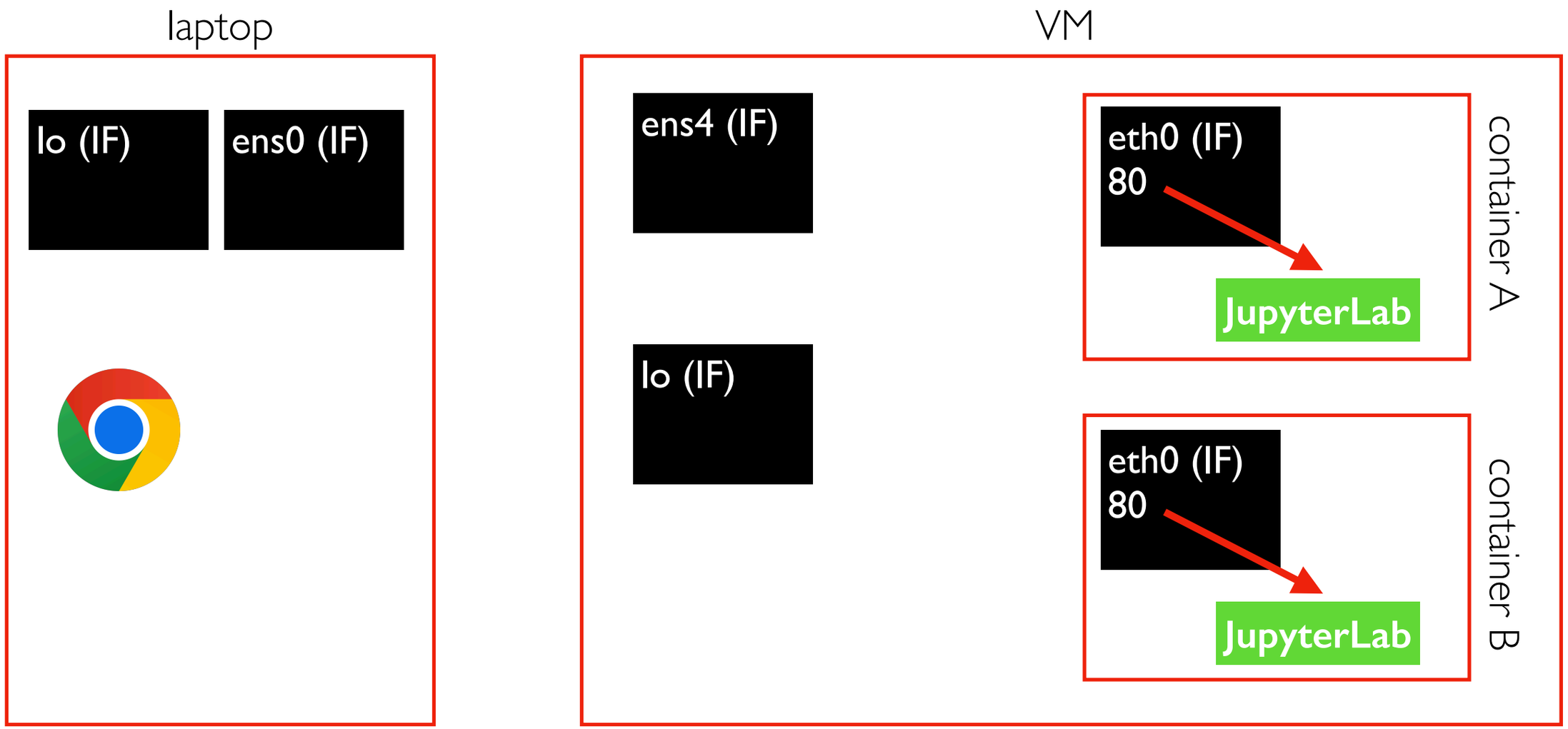
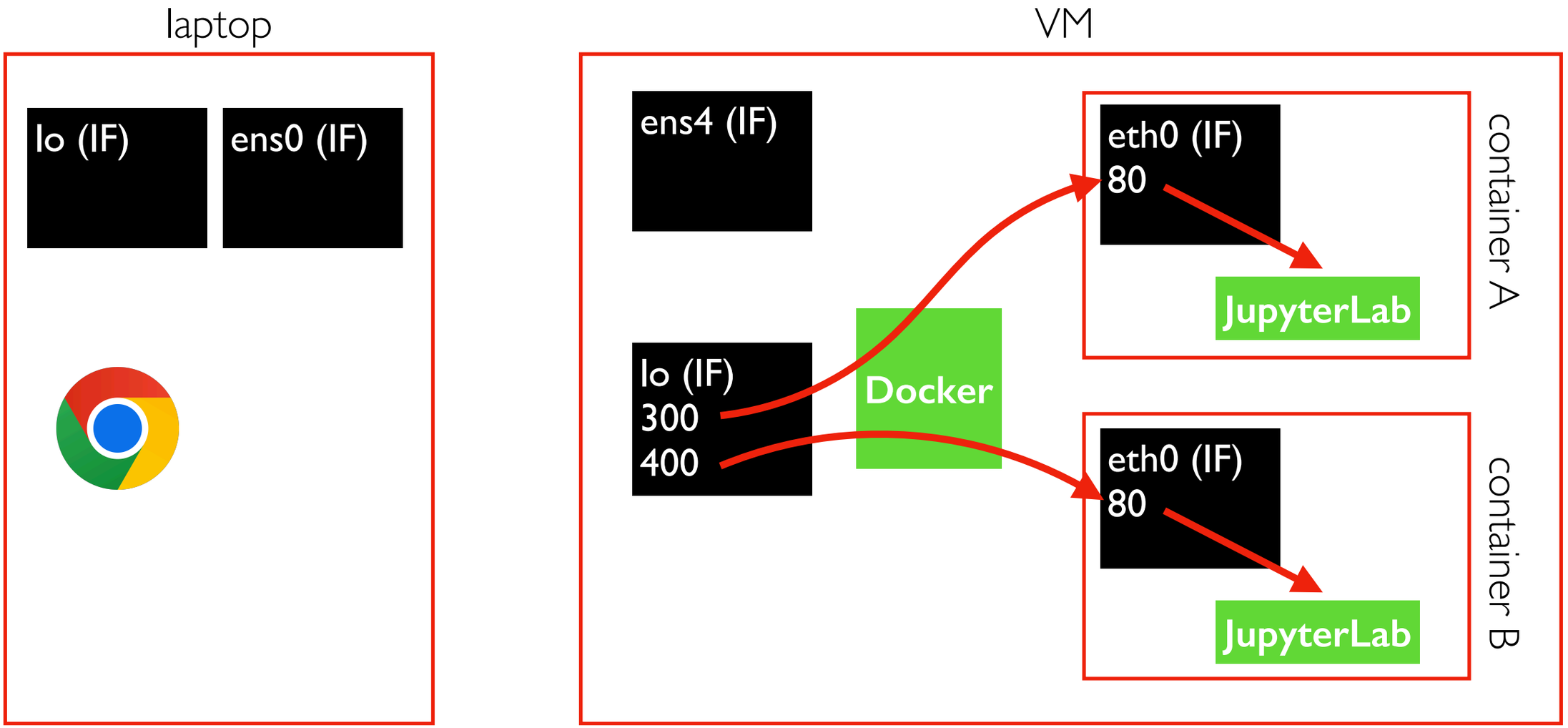
Interfaces (IF) and Ports

both containers have
a virtual port 80



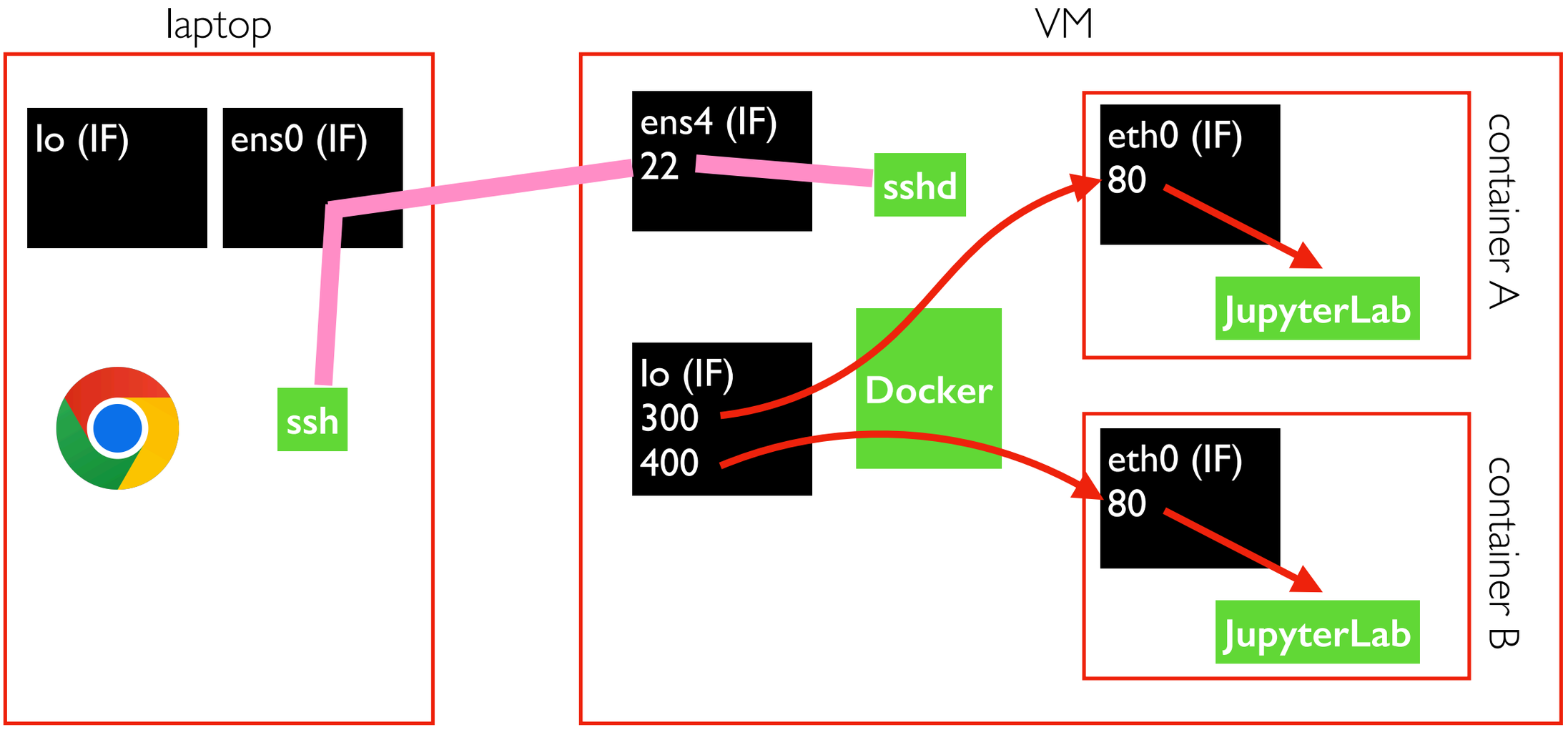

```
docker run -d myimg
docker run -d myimg
```

Interfaces (IF) and Ports




```
docker run -d -p 127.0.0.1:300:80 myimg
docker run -d -p 127.0.0.1:400:80 myimg
```

Interfaces (IF) and Ports

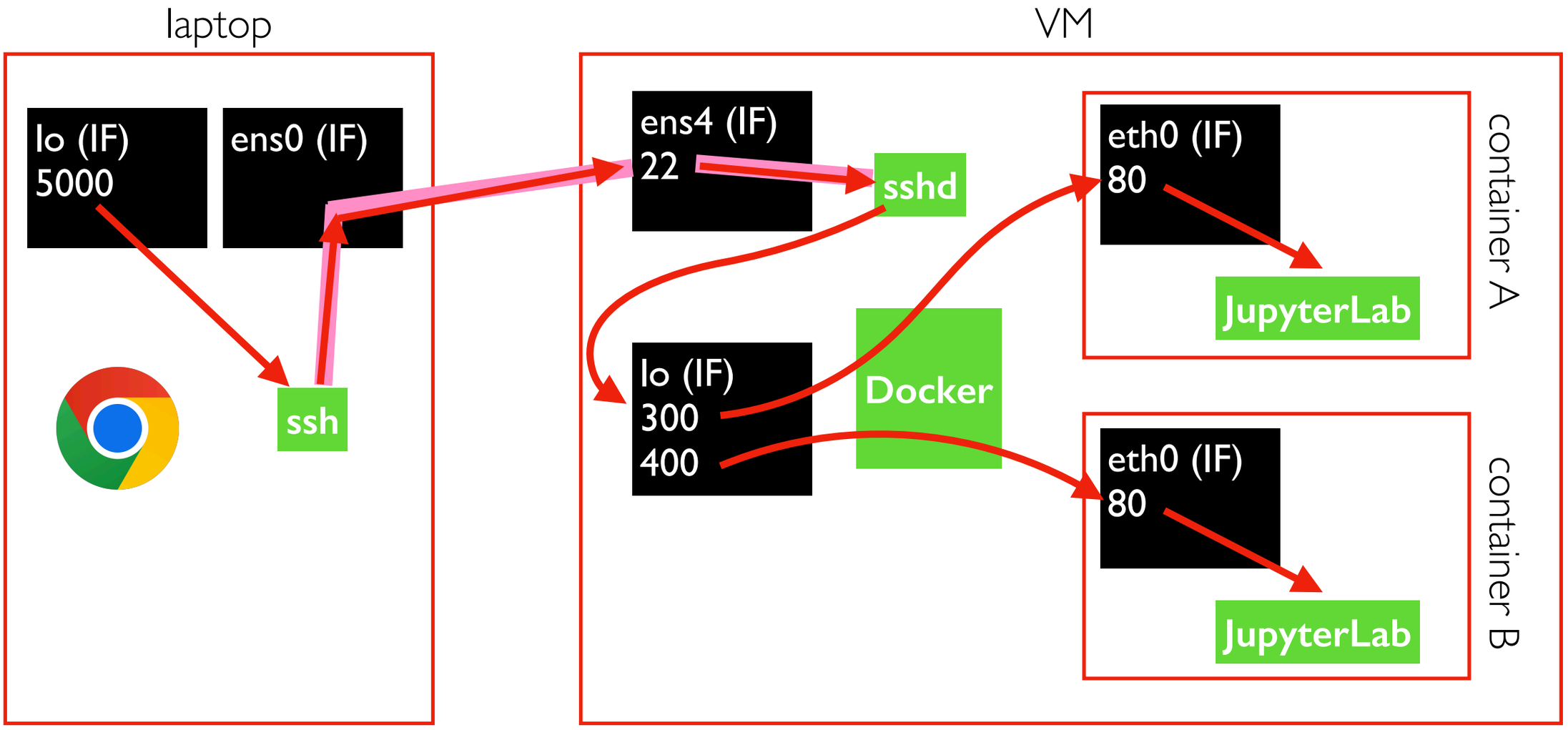


ssh USER@VM

docker run -d **-p** 127.0.0.1:300:80 myimg
docker run -d **-p** 127.0.0.1:400:80 myimg

the SSH connection can be used to send comands and/or forward network traffic

Interfaces (IF) and Ports

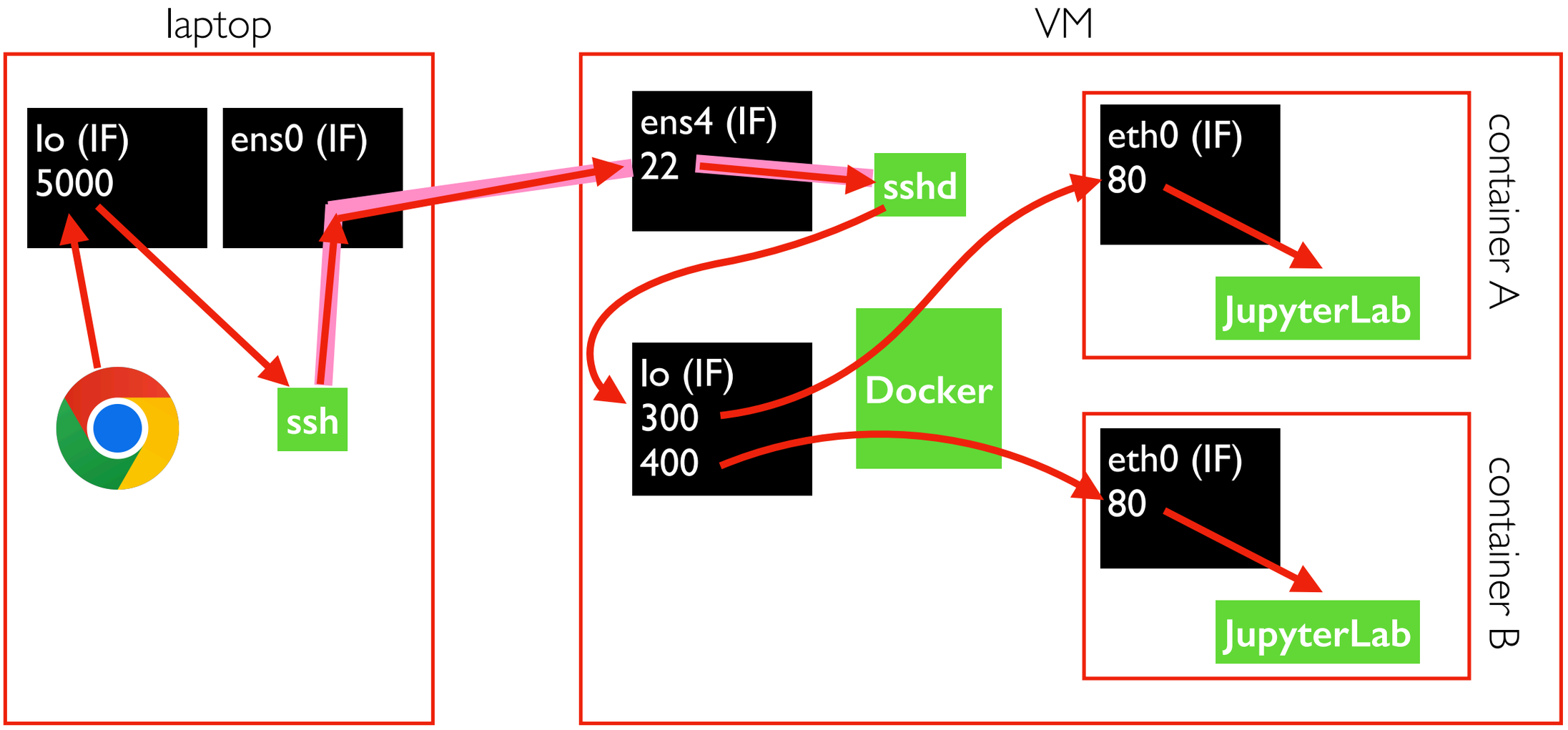


ssh USER@VM **-L** localhost:5000:localhost:300

docker run -d **-p** 127.0.0.1:300:80 myimg
docker run -d **-p** 127.0.0.1:400:80 myimg

the SSH connection can be used to send comands and/or forward network traffic

Interfaces (IF) and Ports



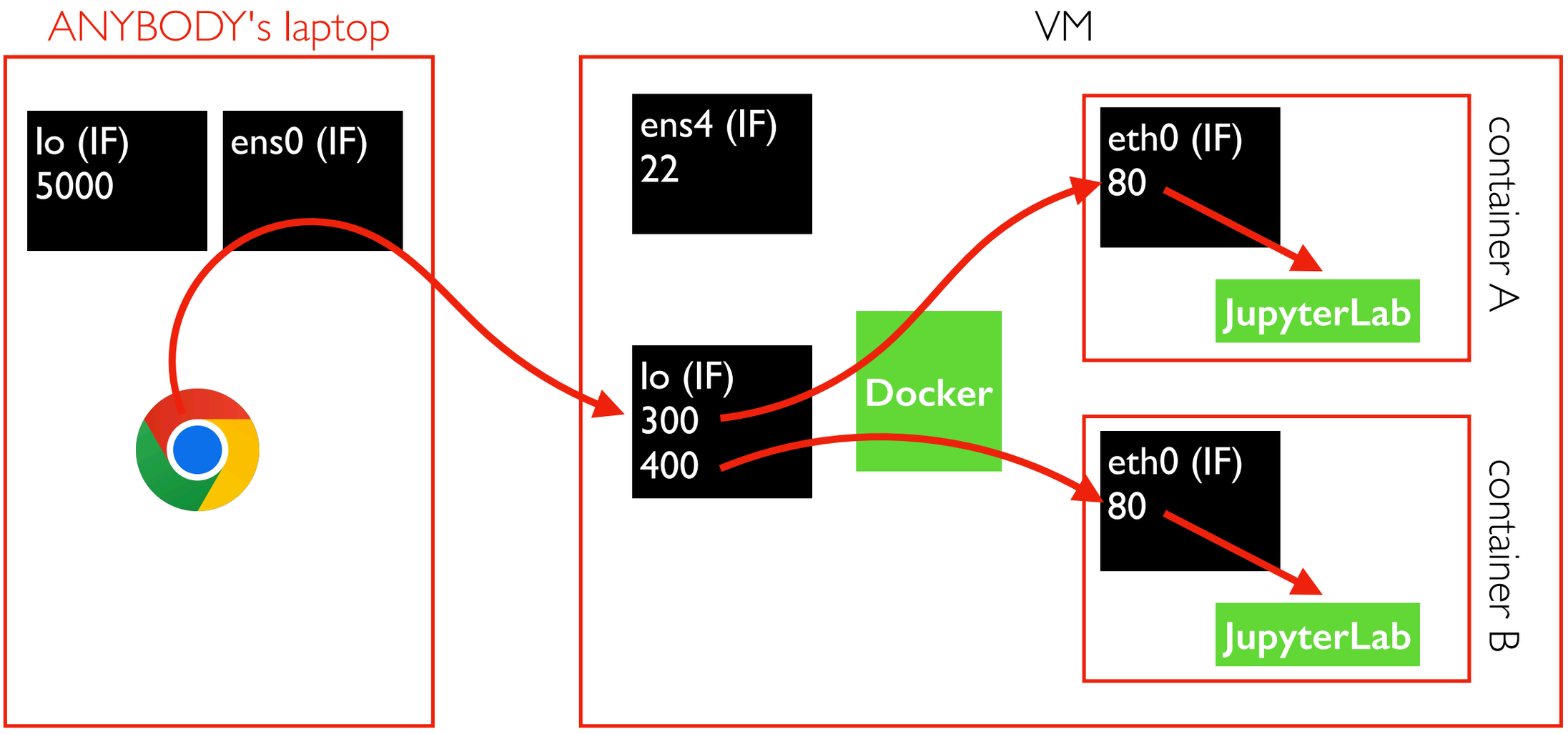
ssh USER@VM **-L** localhost:5000:localhost:300

docker run -d **-p** 127.0.0.1:300:80 myimg
docker run -d **-p** 127.0.0.1:400:80 myimg

http://localhost:5000/lab (in browser)

yay! You can connect to JupyterLab
inside a container running on your VM

Interfaces (IF) and Ports



docker run -d **-p** 300:80 myimg

docker run -d **-p** 0.0.0.0:300:80 myimg

Careful, default is to listen on all ports!

Other security:

- firewall (block port 300)
- password (in JupyterLab)

Demos...

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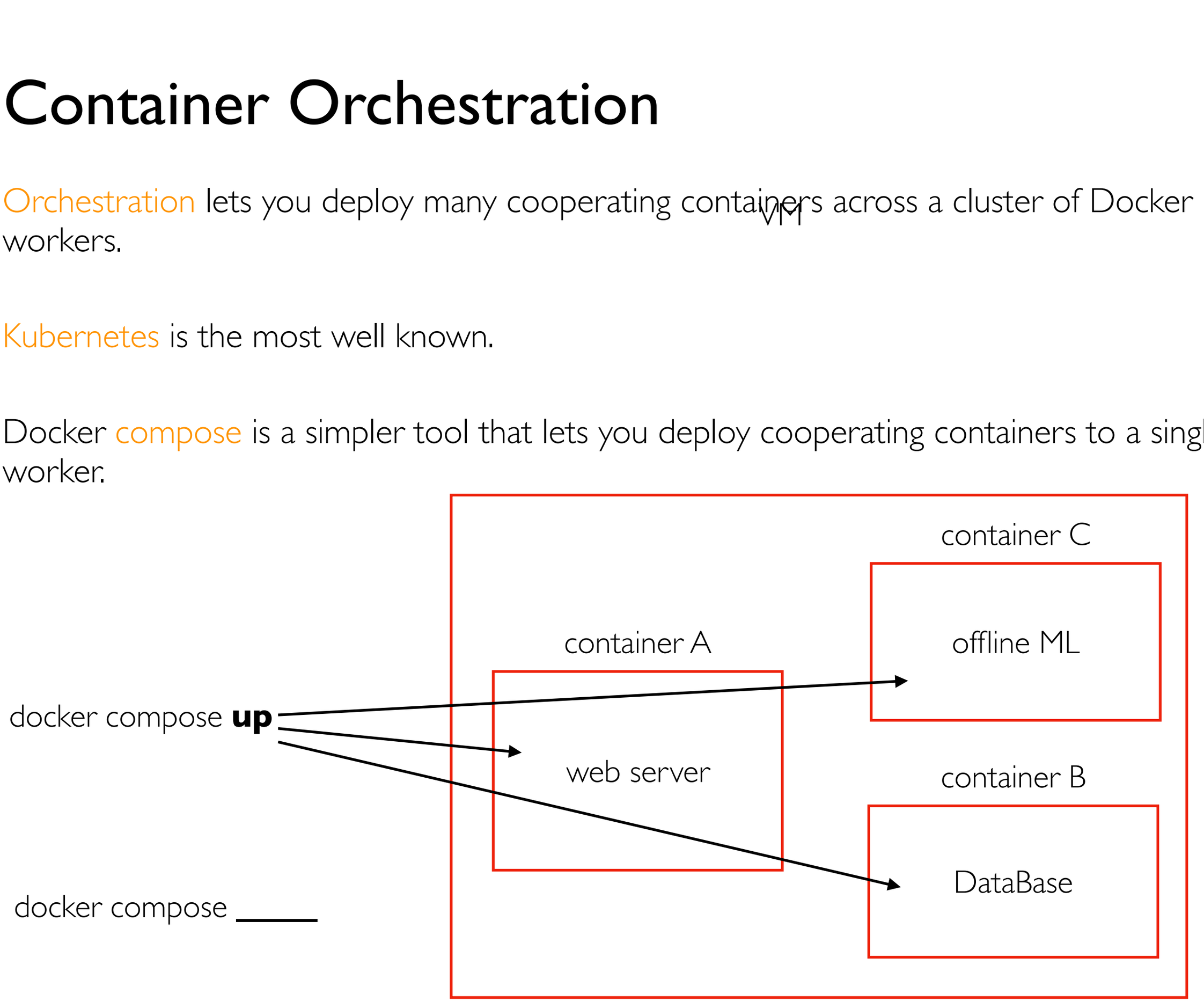
Container Orchestration

Orchestration lets you deploy many cooperating containers across a cluster of Docker workers.

Kubernetes is the most well known.

Docker compose is a simpler tool that lets you deploy cooperating containers to a single worker.



Demos...