
IOT TECHNOLOGY SOLUTIONS
An introduction to Docker
github.com/defano/docker-tutorial
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IOT TECHNOLOGY SOLUTIONS

What's in store?

Part 1: An introduction to Docker

- ✓ What is Docker? What's it good for?
- ✓ Docker key concepts and terminology
- ✓ A brief command-line reference
- ✓ Other products in the ecosystem

Part 2: Hands-on lab exercises: *(as time allows)*

- ✓ Pull images from Docker Hub and run them
- ✓ Create your web server image
- ✓ Link it to a Redis cache container
- ✓ Orchestrate the system with Compose

Can't follow along tonight? Step-by-step lab instructions are available in the GitHub repository:
github.com/defano/docker-tutorial

What is it?

Docker lets you package an application with all its dependencies and infrastructure and execute it anywhere the Docker Engine is installed.

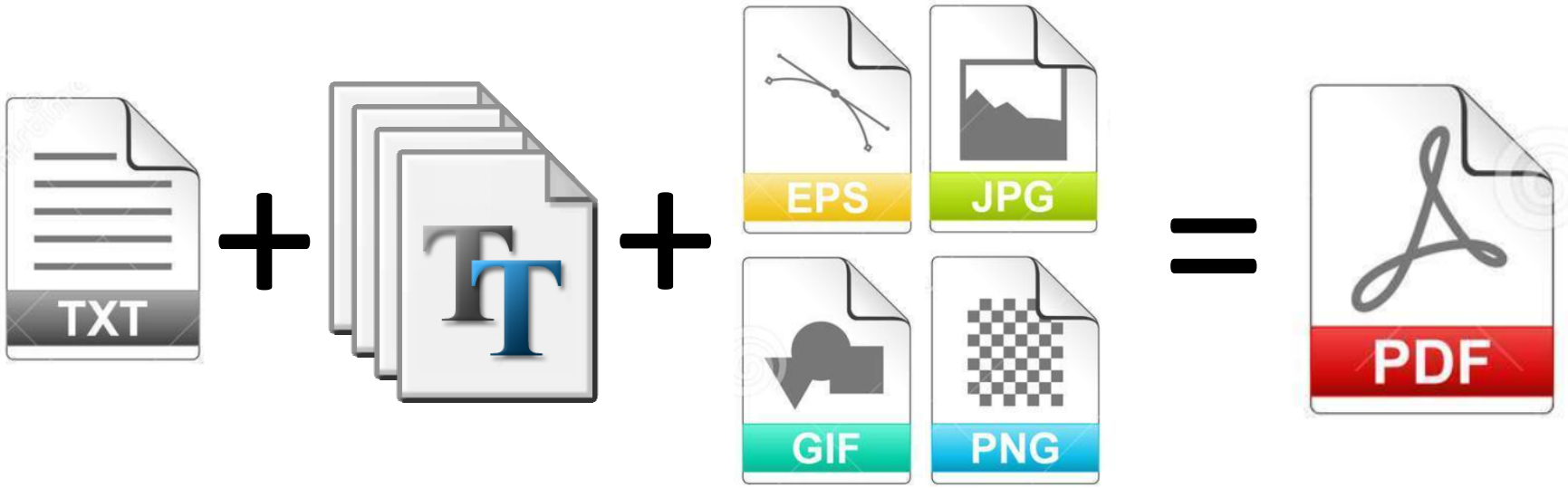
“Build, ship, run”

An ecosystem, really

Docker Engine … for building and running Docker Containers	Docker Swarm … for clustering Docker hosts
Docker Compose … for provisioning multi-container Docker applications	**Docker Hub Registry** … for publishing Docker images to the community
Docker Trusted Registry … for organizations that need a private Docker registry	Docker Cloud … for managing Docker hosts on a cloud service provider (like AWS)
Docker Machine … for running Docker on machines that aren't natively supported	Universal Control Plane … for IT departments to deploy and secure Docker apps in thier firewall
Docker Toolbox & Kitematic … for getting started quickly on a Mac or Windows machine	Docker Notary … for signing Docker images and managing trust relationships

Red denotes tools we'll discuss in this presentation.

Like PDF, but for apps

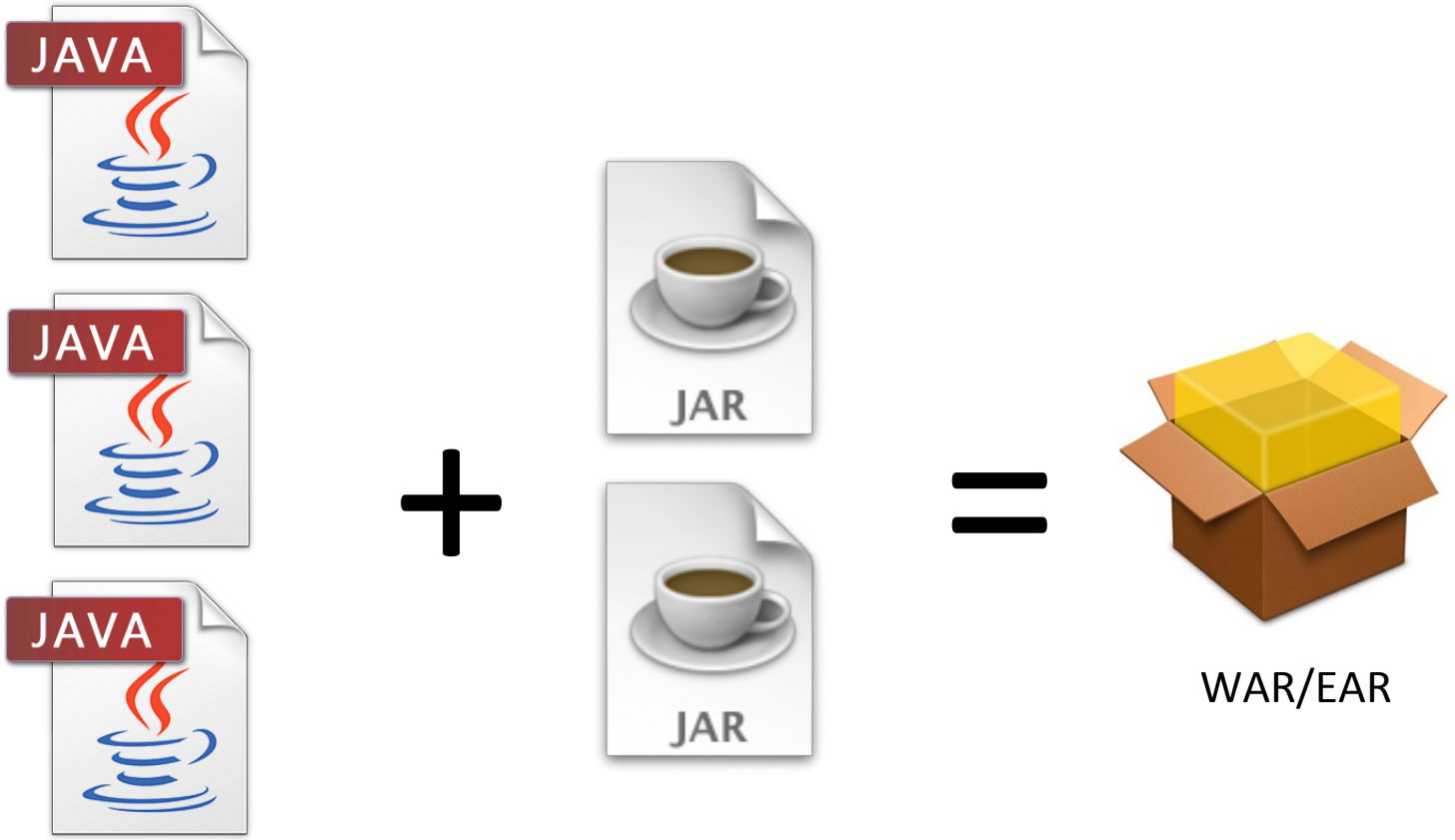


Your opinions on Shakespeare…

… in a bunch of fonts you bought at Babbage's…

… decorated with clip art from The Print Shop, looks like…

Don’t we have that already?

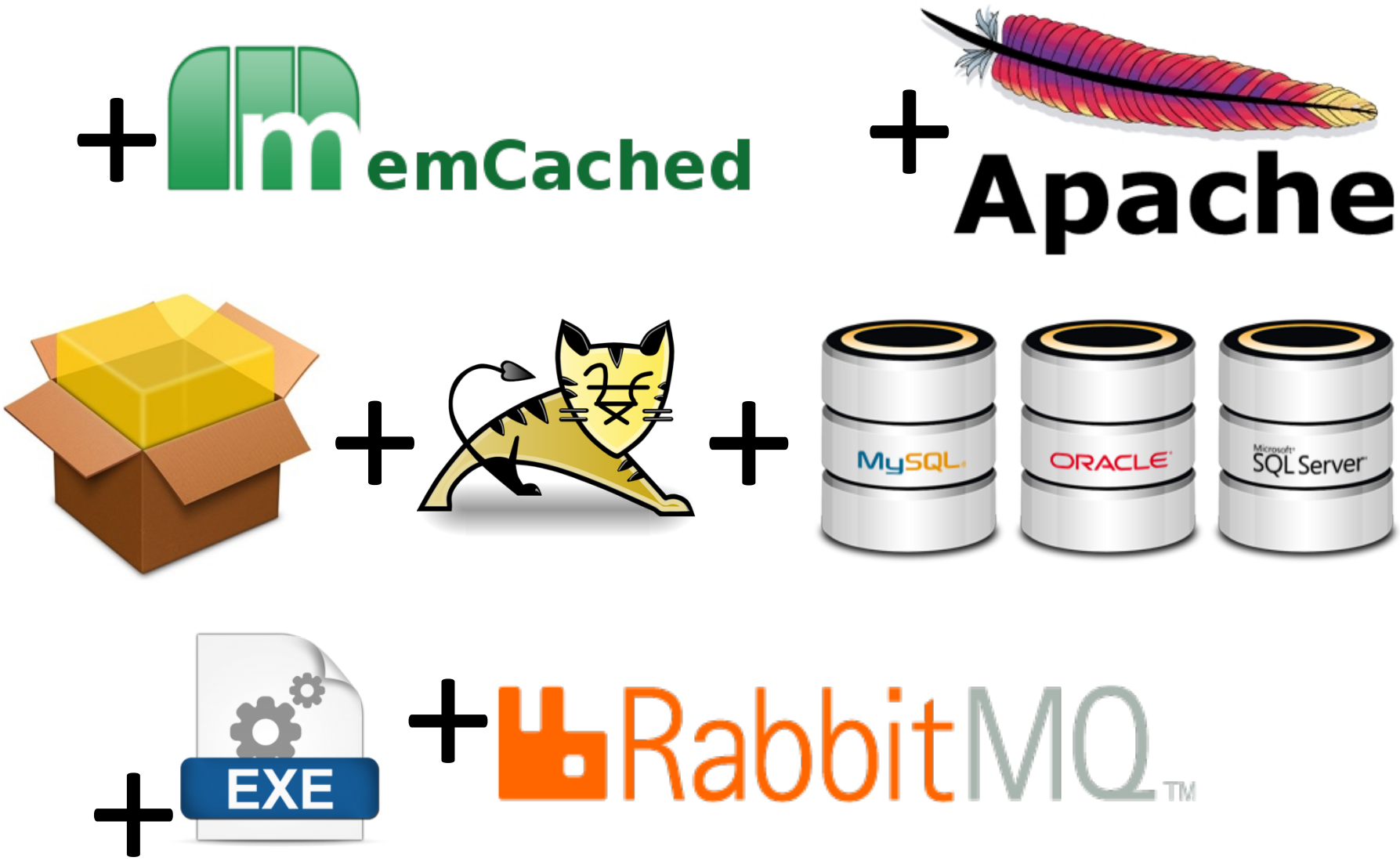


Your code…

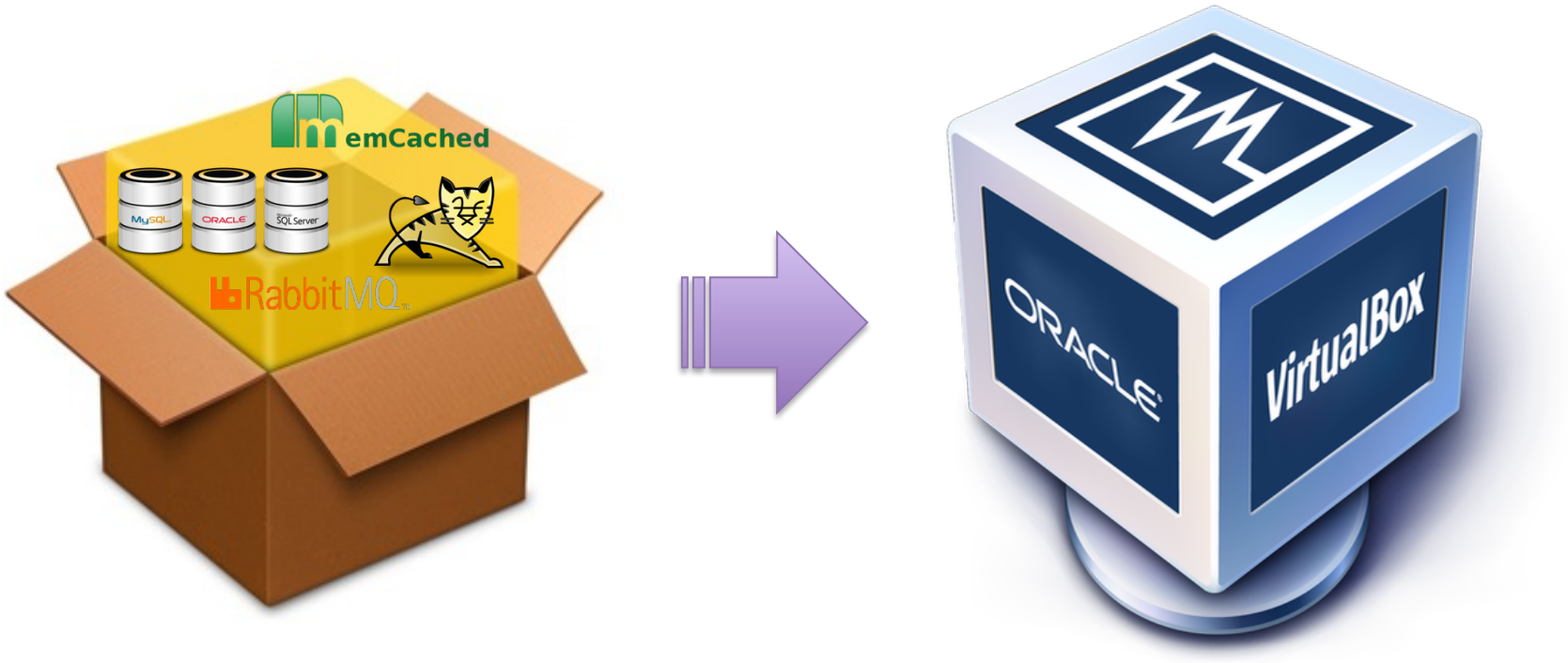
… plus a bunch of third party libraries...

… equals an industry-standard, run anywhere package!

Sure, until this happens...



In that case, I'll use a VM



VMs are good, Docker is better

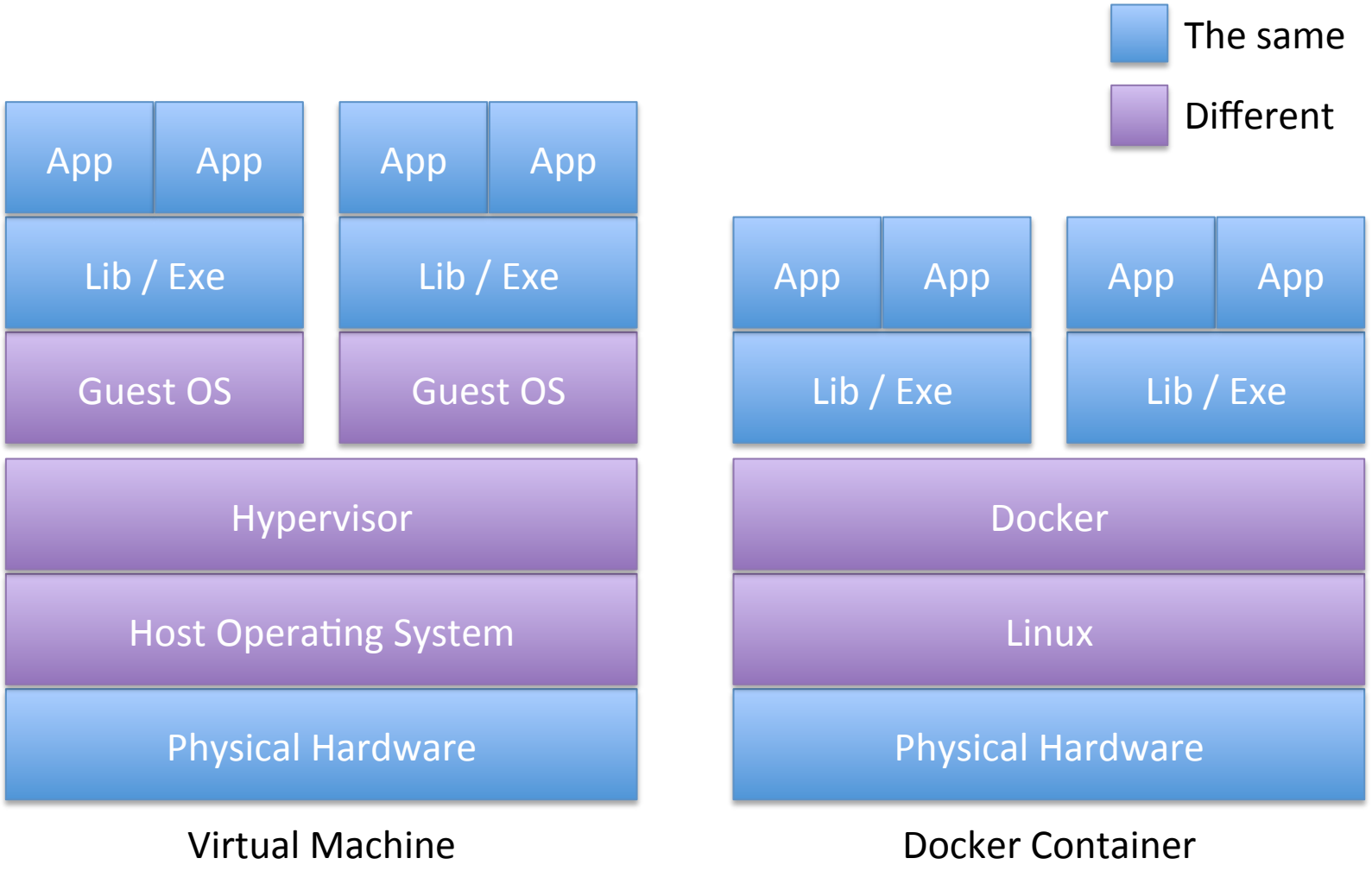
Virtual Machines:

- ✓ Virtualize physical hardware; VMs share host hardware
- ✓ Start in 30-60 seconds
- ✓ Make cloud-to-cloud portability hard
- ✓ Machine images are big and atomic
- ✓ Craptacular for development
- ✓ More secure
- ✓ Better for environments with lots of OSs; many apps running on one machine

Docker Containers:

- ✓ Virtualize Linux; containers share hardware *and* OS.
- ✓ Start in 0.5 seconds
- ✓ Make cloud-to-cloud portability easy
- ✓ Container images are small and composite
- ✓ Great for development
- ✓ Less secure
- ✓ Better for Linux-only environments and micro-services

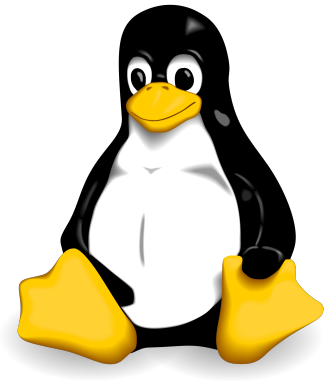
What's it look like?



**Illinois state law requires that every presentation about Docker show this diagram.*

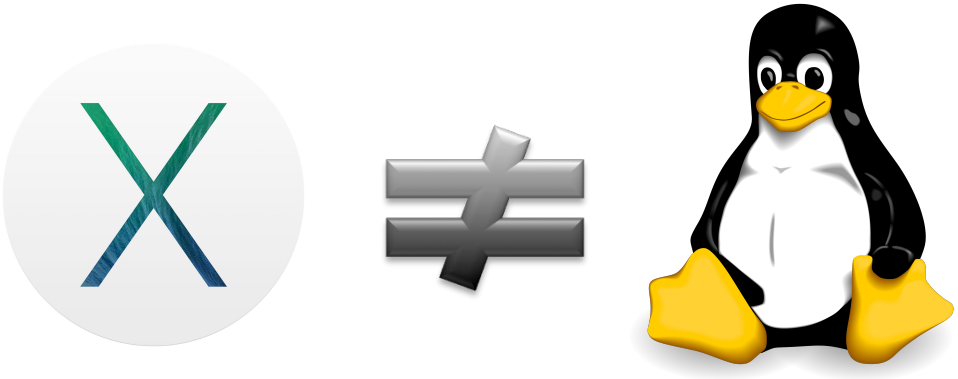
Repeat after me…

Containers *always* run on Linux.



But Macs are Linux, right?

Cool. So containers run on my Mac, right?



Nope. Docker is reliant on kernel features not present in Apple's Darwin/XNU kernel.

No shoes, no shirt, no Docker

No Linux, no problem: Run containers with **Docker Machine**.

- ✓ Typically just Linux running in a virtual machine.
- ✓ Docker Machine supports drivers for different VM engines and cloud providers; most developers just use VirtualBox.

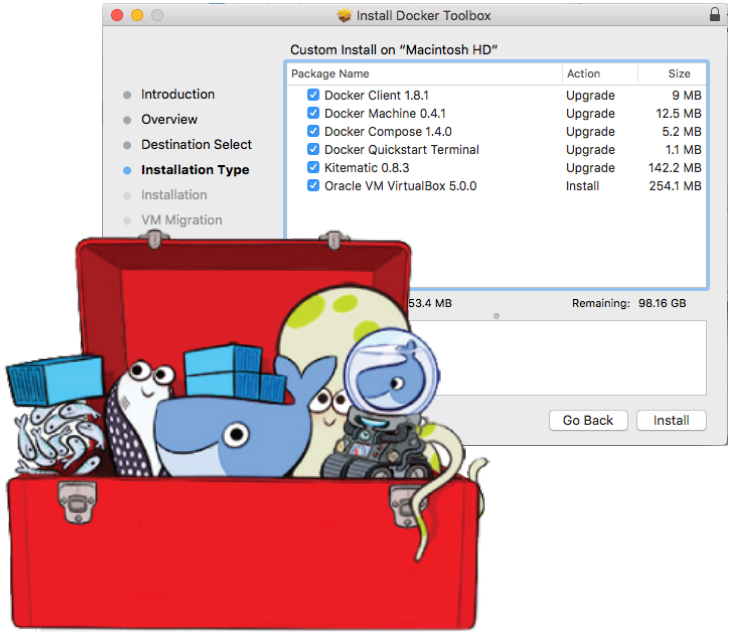
Easy to install

Mac and Windows users can get started quickly with the **Docker Toolbox**

One-stop shop for Mac and Windows users; installs everything you'll need:

- ✓ Docker Machine
- ✓ Docker Engine
- ✓ Docker Compose
- ✓ Docker Kitematic
- ✓ Oracle VirtualBox

Linux users can install these tools individually.

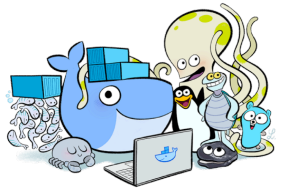


https://www.docker.com/products/docker-toolbox

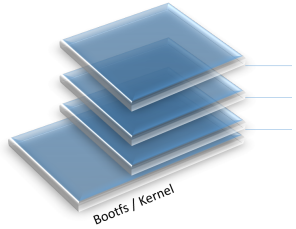
Docker key concepts

Master Docker by understanding these **key concepts**:

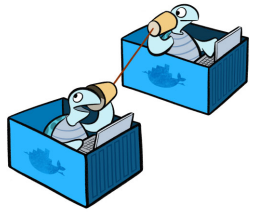
- ✓ Understand the difference between **images**, **containers** and **machines**.



- ✓ Know how images are constructed through a **union mount**.



- ✓ Don't let the **port-spaghetti** of containers running inside virtual machines running on your laptop make your head explode.



Containers and images

A **container** is an instance of a Docker image.

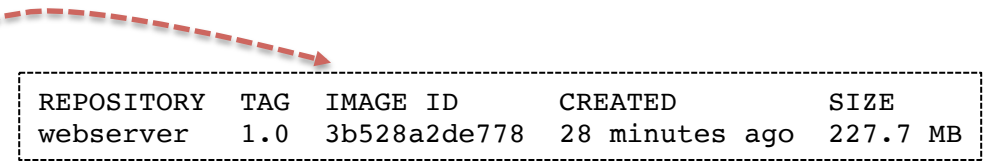
An **image** defines the contents of a filesystem, plus defaults:

- Exposed network ports
- Volumes (writeable disk space on the host)
- Linux shell commands to initialize container (i.e., start your app)

Containers and images

Images and containers are identified by **ID** or **name** and **tag**.

- **ID** is a hash assigned by Docker
- **Name** is human-readable value:
  - ✓ Optional for images
  - ✓ Auto-assigned to containers when not specified (i.e., `nice_schnauzer`)
- **Tag** is a human-readable value:
  - ✓ For images only (no tags on containers); typically used to denote version
  - ✓ When not explicitly specified, `latest` is used.



Containers and images

A **volume** is a directory on the Docker host that's read / writeable to the container.

A container communicates to the outside world through one or more **exposed network ports**.

Containers and images

Images are not monolithic.

- ✓ A Docker image *is not* a simple “disk image”

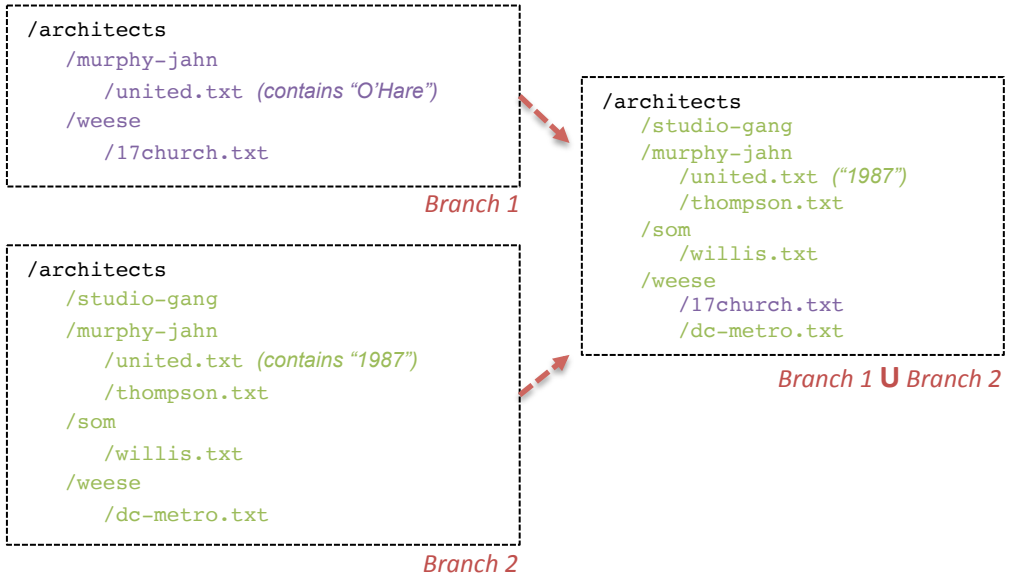
Images are comprised of other images, one atop another, merged together in a **union filesystem**.

- ✓ Docker manages these relationships for you:

  A reference to an image automatically includes all its dependent layers.

Okay, but what the heck is a **union filesystem**?

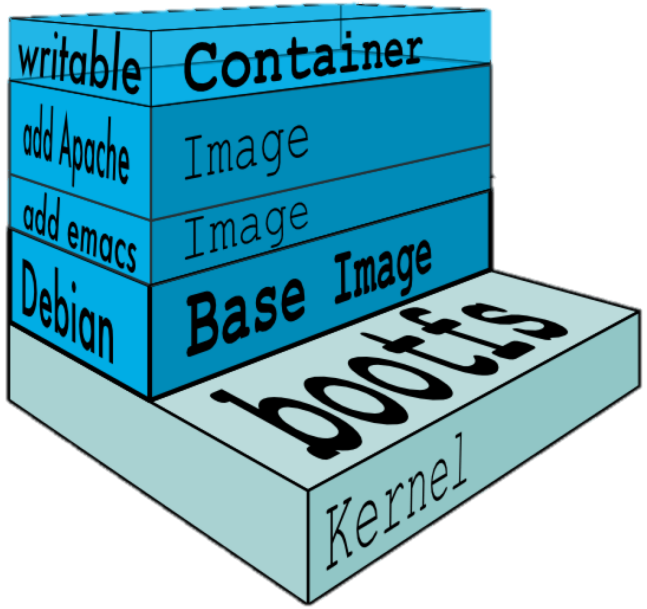
- Mounts multiple filesystems (called "**branches**") at the same mount point.
- Non-conflicting nodes appear merged together in union: n_1 **U** n_2 **U** n_3
- Conflicting nodes appear in mount order (last mounted node wins)
- **Read only**. What happens when you write?



Union filesystems

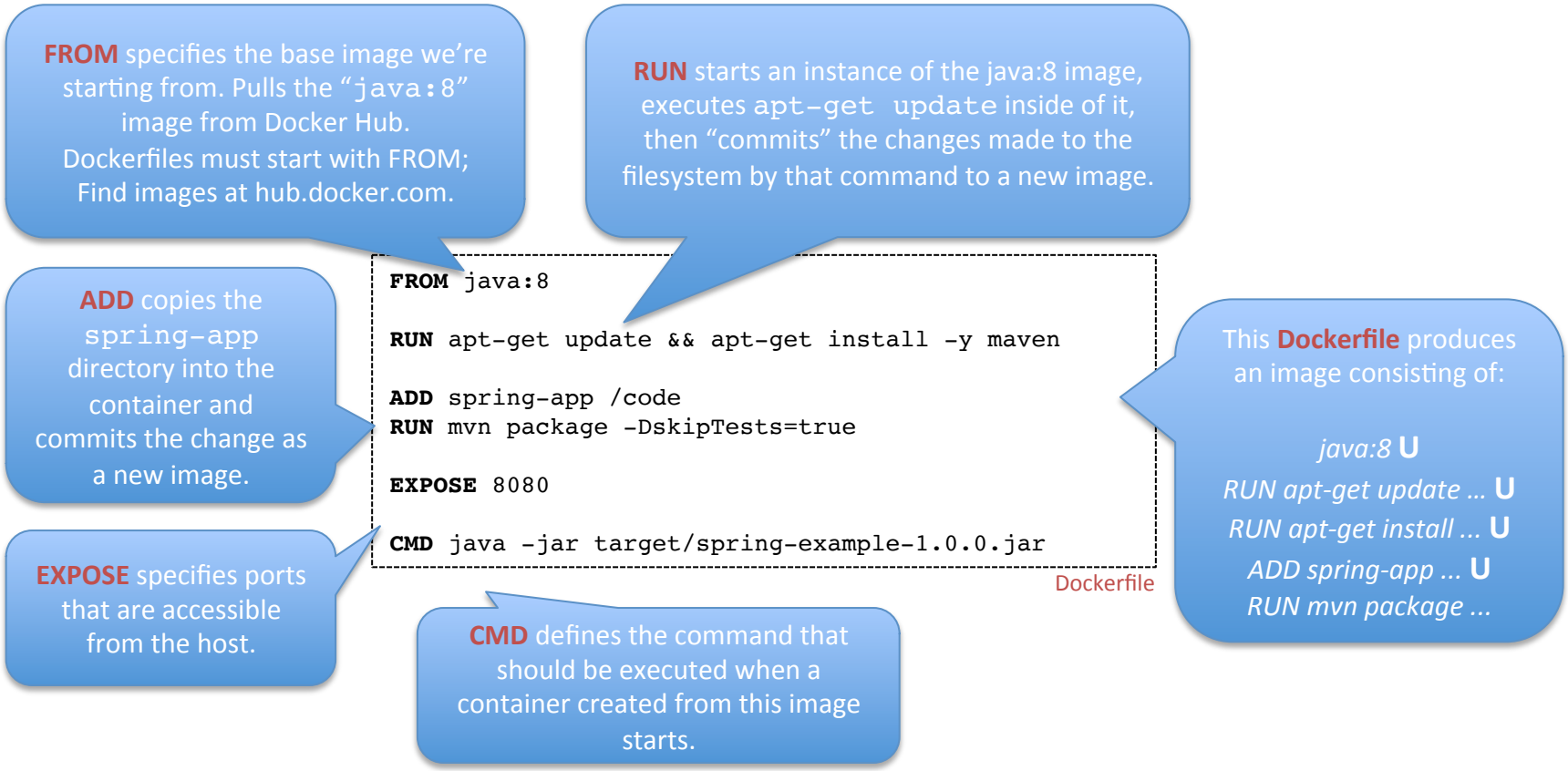
Which layer is modified **when I write** to Docker's union filesystem?

- The top-most layer is provided by the container and is writeable.
- This writable layer is discarded when container stops running. **Your changes are not saved.**
- Writable layer can be committed to create a new Docker image.
  (This is how the Dockerfile creates new images.)



The Dockerfile

Docker images are created from a **Dockerfile**.



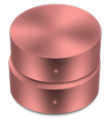
The Dockerfile

FROM java:8

Pulls image from Docker Hub

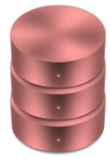
RUN apt-get update

Runs 'apt-get' command in an ***intermediate container*** *created from the java:8 image*



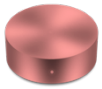
ADD spring-app /code

Runs container created from image produced in last step; adds spring-app directory (on host) to /code on image



CMD java –jar ...

Specifies command that executes by default when container runs



Intermediate images and containers are deleted automatically by default when build completes.

Command reference

Create an image from a Dockerfile:

(The trailing '.' is the path to the Dockerfile)

```
$ docker build -t webserver:1.0 .
```

Create a named container from an image:

(Call the container "defano/server" and publish the container's exposed port 80 on the Docker Host at 8080)

```
$ docker create -p 8080:80 --name="my-server" webserver:1.0
```

Start an existing container by name:

(Alternatively, we could specify the container by hash prefix)

```
$ docker start my-server
```

Command reference

Run a command in a new container…

(Creates a new container from the webserver:1.0 image and executes ping inside of it)

```
$ docker run webserver:1.0 /bin/ping www.google.com
```

… or run the image with its default command:

(When no command is specified, the CMD from the Dockerfile will execute)

```
$ docker run webserver:1.0
```

Execute a command in a running container:

(Opens a bash shell in the container named "defano/server"; -it indicates command is interactive and needs a PTTY)

```
$ docker exec –it my-server bash
```

Command reference

List all Docker containers:

(Forego the –a to list only running containers)

```
$ docker ps -a
```

List all Docker images in your local repository:

(Add a –a to show intermediate images, too)

```
$ docker images
```

Show logs (output) of a container:

(Use –f to "follow" the output; otherwise, display current output and exit. Works on running and stopped containers!)

```
$ docker logs -f my-server
```

Command reference

Delete a container:

(Deletes the container named "my-server"; could also specify a hash. Container must not be running.)

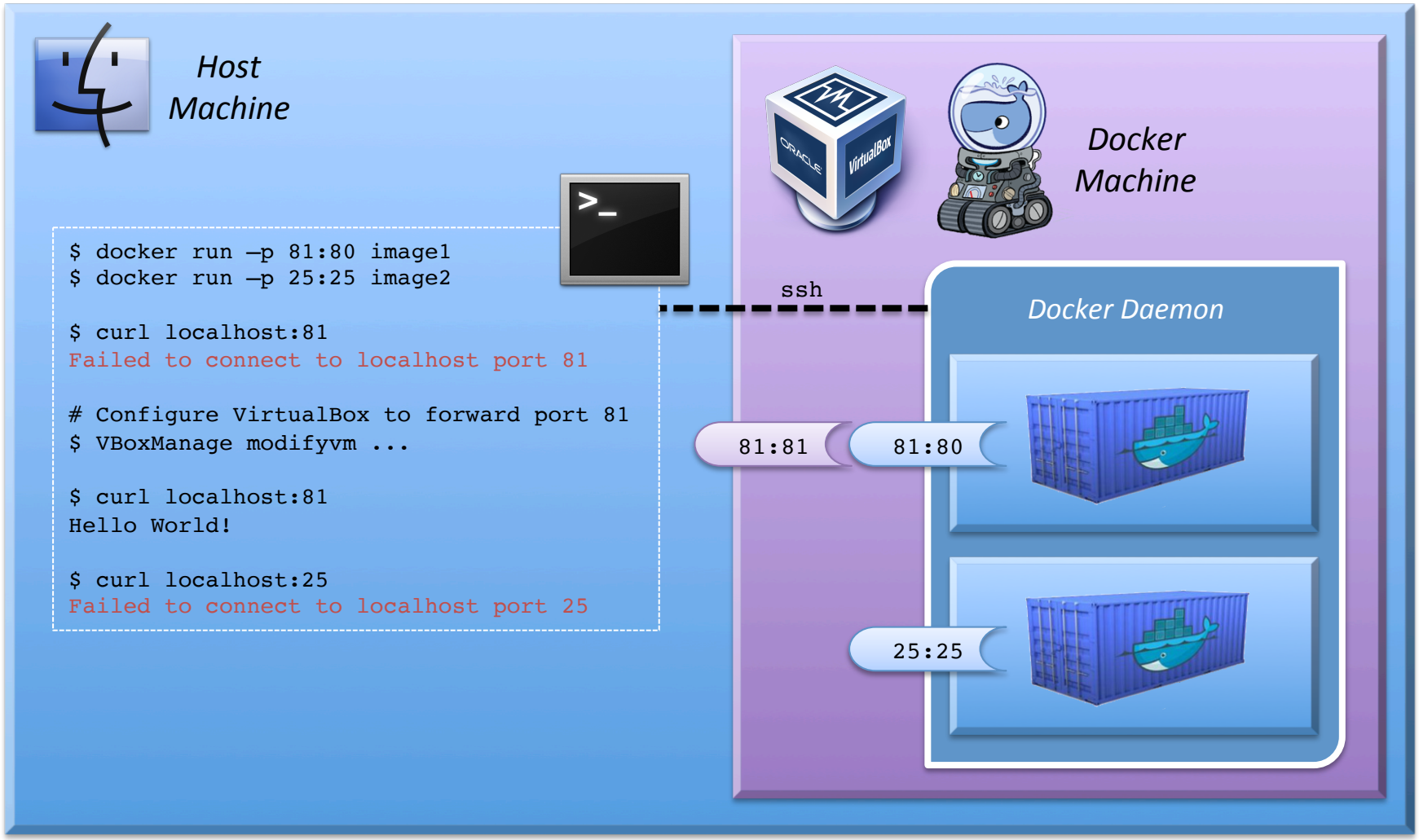
```
$ docker rm my-server
```

Delete an image:

(Deletes the webserver:1.0 image; could also specify a hash. All derived containers must be removed first.)

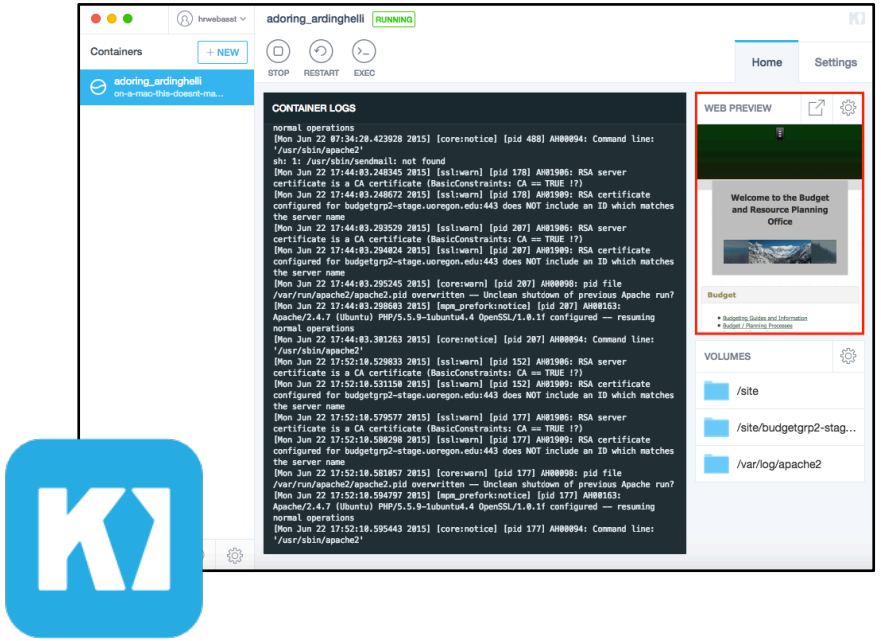
```
$ docker rmi webserver:1.0
```

Docker port spaghetti

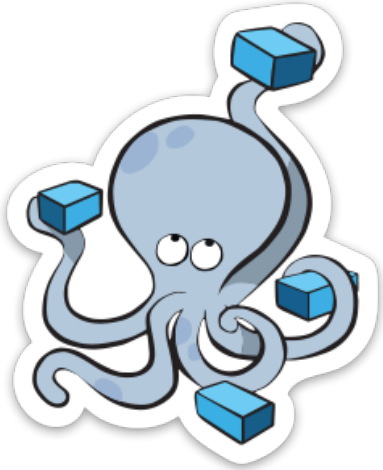


Kitematic is an easy-to-use Docker GUI for Mac and Windows.

- ✓ Browse and create containers from Docker Hub directly within the app.
- ✓ Provision containers, view logs, map ports and preview websites.
- ✓ No need to learn command-line syntax.



Docker Compose



Use **Docker Compose** to script the creation of multi-container applications

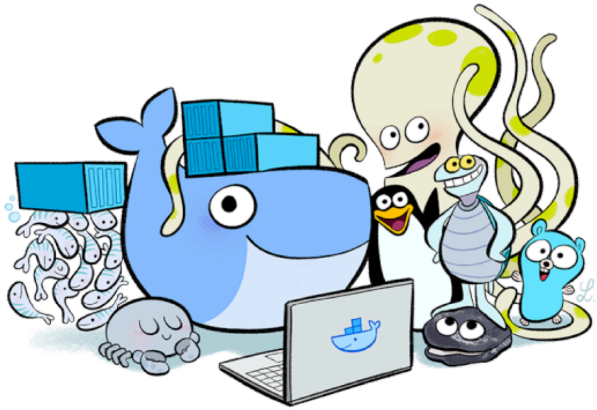
- ✓ **Great for development environments**
  Starting and linking lots of containers is a pain.

- ✓ **Great for CI system tests**
  Start a multi-container app with `docker-compose up`*, then execute your tests.*

- ✓ **Great for single-host deployments**
  Running all your containers on one physical host, then this is your tool.

Docker Hub Registry is a repository for open-source images.

- Search for images on the web at http://hub.docker.com or use `docker search <term>`
  - Image names typically following the form `<organization>/<image>:<tag>`
  - Use tags to denote versions, variants, etc.
- Pull an image (for use on your host) with `docker pull <image>`
- Share your masterpiece with the world: `docker push <image>`
  - Worry not; required layers will be pushed, too.



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