

Welcome to Week 2

Virtual Mentored Academy

Docker Fundamentals



PLURALSIGHT

Hello

HELLO
my name is

Allen Sanders
Senior Technology Instructor
Pluralsight ELS

About me...



- 27+ years in the industry
- 23+ years in teaching
- Certified Cloud architect
- Passionate about learning
- Also, passionate about Reese's Cups!



Agenda

- Containerization as a Deployment Strategy
- Docker as a Containerization Platform
- Azure Container Registry (ACR)
- Azure Container Instances (ACI)
- Docker Compose



How we're going to work together

- Slides and words to highlight key concepts
- Demos to bring those concepts “to life”
- Lab work (which will take place in sandboxes provided by “A Cloud Guru”) for hands-on reinforcement
- NOTE: I welcome being interrupted – if you need more info, or clarification, or anything else, just break in and ask. I am here to help you.



Containerization as a Deployment Strategy

What Are the Hosting Options with Cloud?

- ☐ IaaS
- ☐ PaaS
- ☐ Serverless / FaaS
- ☐ SaaS
- ☐ Containers



What do they all mean?



So, What Are Containers?

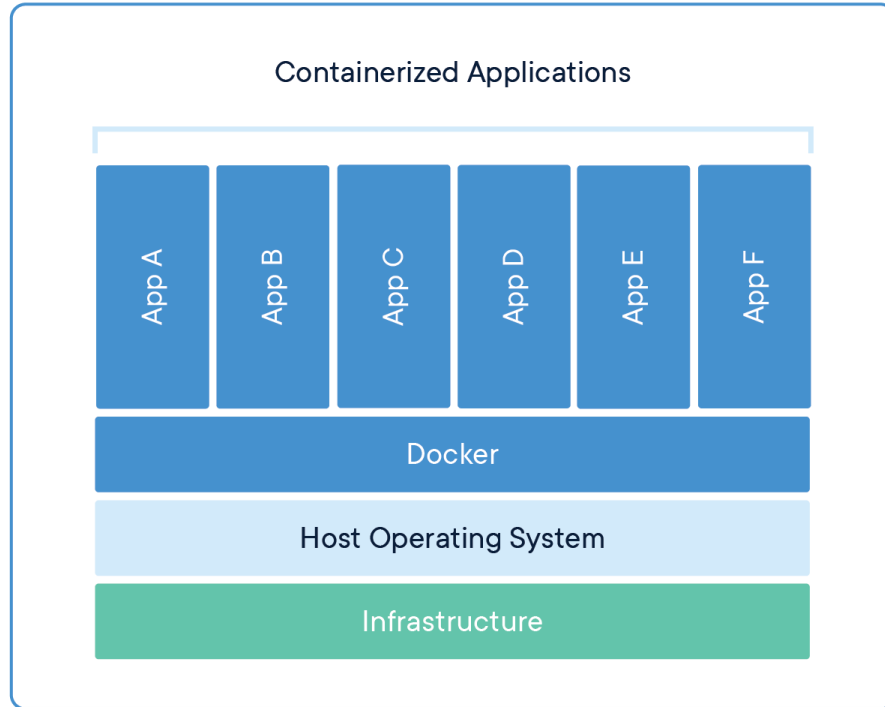
- Form of virtualization at the app packaging level (like virtual machines at the server level)
- Isolated from one another at the OS process layer (vs VM's which are isolated at the hardware abstraction layer)
- Images represent the packaging up of an application and its dependencies as a complete, deployable unit of execution (code, runtime and configuration)



So, What Are Containers?

- A platform (e.g., Docker) running on a system can be used to dynamically create containers (executable instances of the app) from the defined image
- Typically, much, much smaller than a VM which makes them lightweight, quickly deployable and quick to “boot up”
- An orchestration engine (e.g., Kubernetes) might be used to coordinate multiple instances of the same container (or a “pod” of containers) to enable the servicing of more concurrent requests (scalability)

So, What Are Containers?





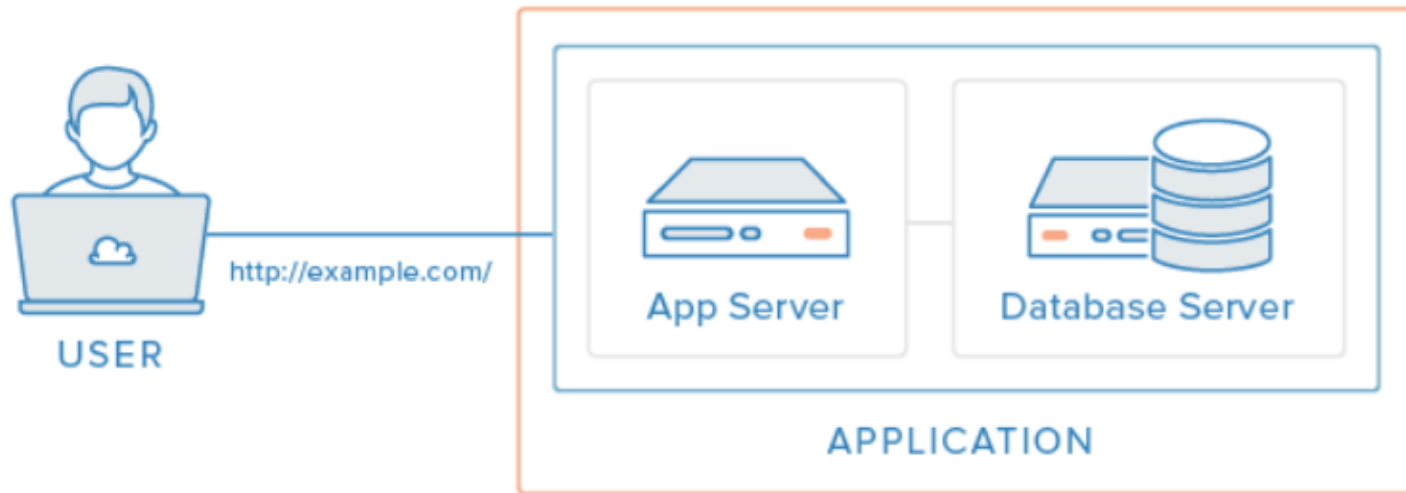
So, Why Containers?

- Abstracts away the code implementation so you can deploy in a platform-agnostic manner, writing in the language of your choice
- Aligns strongly with the principles and practices of DevOps
- Helps leverage the power of the cloud
- Speeds up important non-coding activities (infrastructure spin-up, testing, CI/CD tasks, DevSecOps, code quality checks, etc.
- Helps breed consistency vs. “snowflake”

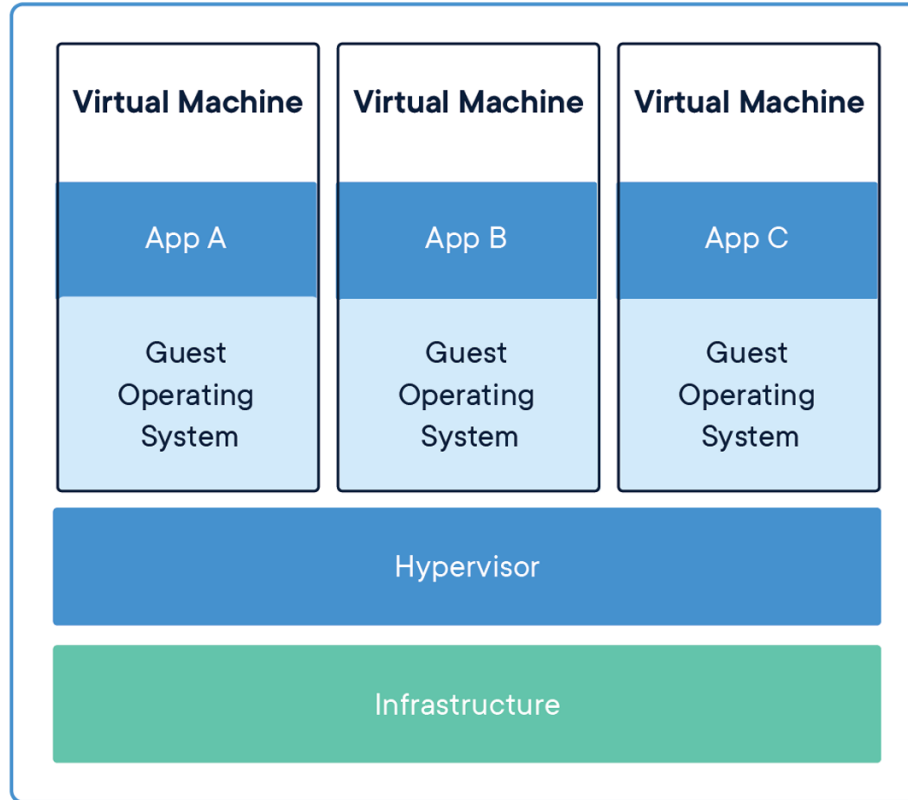


Docker as a Containerization Platform

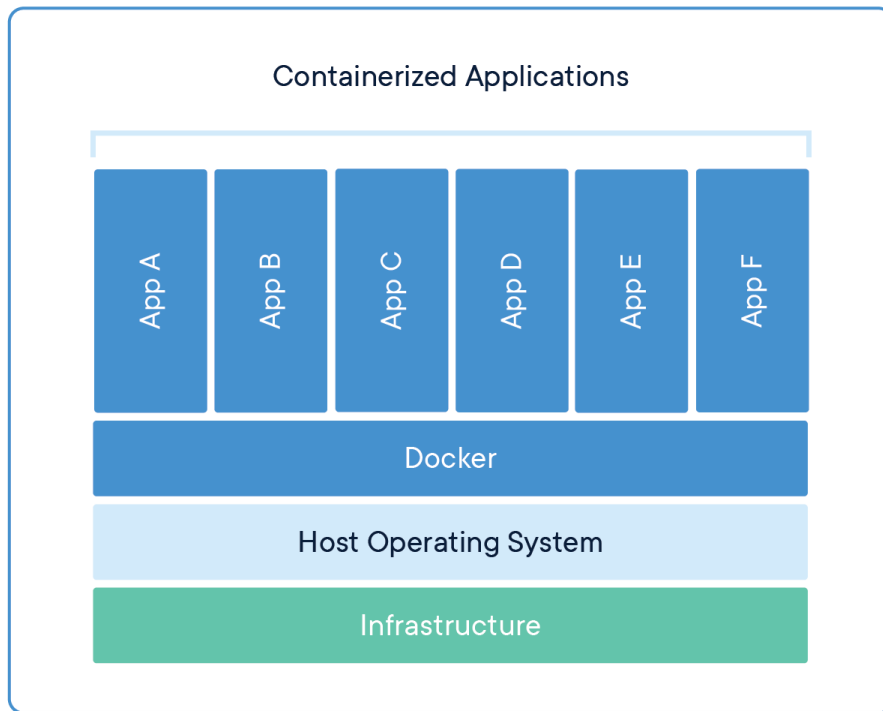
Evolution of Containers – Client/Server



Evolution of Containers – Virtual Machines



Evolution of Containers – Containers





What is Docker?

- Open-source containerization technology
- Enables deployment of self-contained & isolated application instances
- One of the foundational technologies for supporting microservices



What is Docker?

- Built around the concept of images & containers
- Also, supports composition of a set of containers to be deployed together
- For example, application code + network components + database components



What is Docker?

- Utilizes principles of “immutable infrastructure”
- Complete application environments torn down and recreated as needed
- Helps to minimize infrastructure “drift” and environment inconsistencies



The Dockerfile

- Tells Docker what to do in creating an image for your application
- The commands are all things you could do from the CLI
- Used by the docker “build” command
- Docker build uses this file and a “context” – a set of files at a specified location – to make your image

Dockerfile example

The following creates an image for building/running Java app in container
See <https://github.com/KernelGamut32/dockerlab-repo-sample> for sample

```
Dockerfile X
Dockerfile > ...
1 # Grabs OpenJDK image upon which the new image will be based
2 FROM openjdk:17
3
4 # Creates a new target folder in image
5 RUN mkdir /usr/src/JavaDemoApp
6
7 # Copies current directory contents to newly created folder
8 COPY . /usr/src/JavaDemoApp
9
10 # Switches working directory in image to app folder
11 WORKDIR /usr/src/JavaDemoApp
12
13 # Compiles/builds Java app
14 RUN javac JavaDemo.java
15
16 # Executes new Java app
17 CMD ["java", "JavaDemo"]
18 |
```



Docker Images

- Represent templates defining an application environment
- New instances of the application can be created from the image
- These instances are called containers



Docker Images

- Images are defined via a Dockerfile definition
- Support layers for building up the environment in stages
- Fully defines the application, including all components required to support



Docker Images

- Those components can include:
 - Runtime
 - Development framework
 - Source code
 - Executable instructions for container startup



Docker Images

- Start with a base that gives your app a place to live
 - Needed OS/runtimes/dB server applications, etc.
- Examples:
 - nginx
 - Node
 - MySQL
 - Apache HTTP Server
 - IIS with .NET Runtimes



Docker Hub

- Centralized registry for image storage & sharing
- Can signup for an account – user accounts offer both free and pro versions
- Also, supports organizations for grouping of multiple team members



Docker Hub

- Accessible at <https://hub.docker.com>
- Search feature enables search for image by technology or keyword
- Image detail displays available tags and image variants



Docker Hub

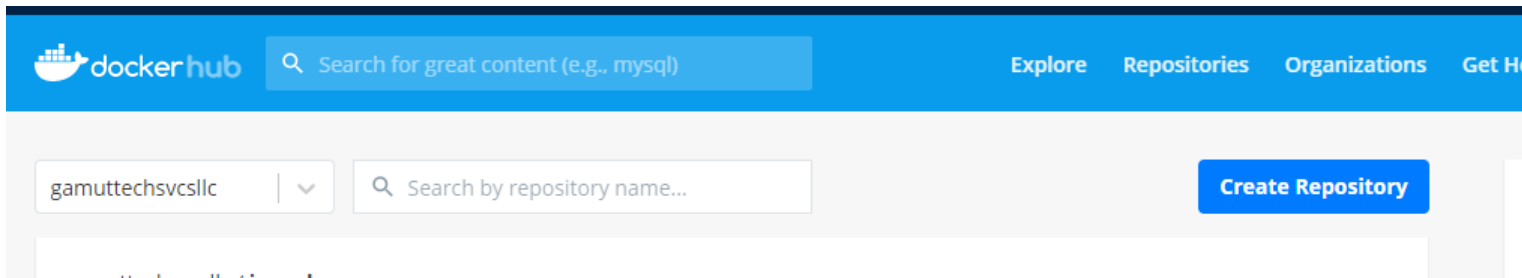
- May also include examples of usage
- Pro account supports image scanning for security vulnerabilities
- Can be useful for image reuse and image sharing across a dev team



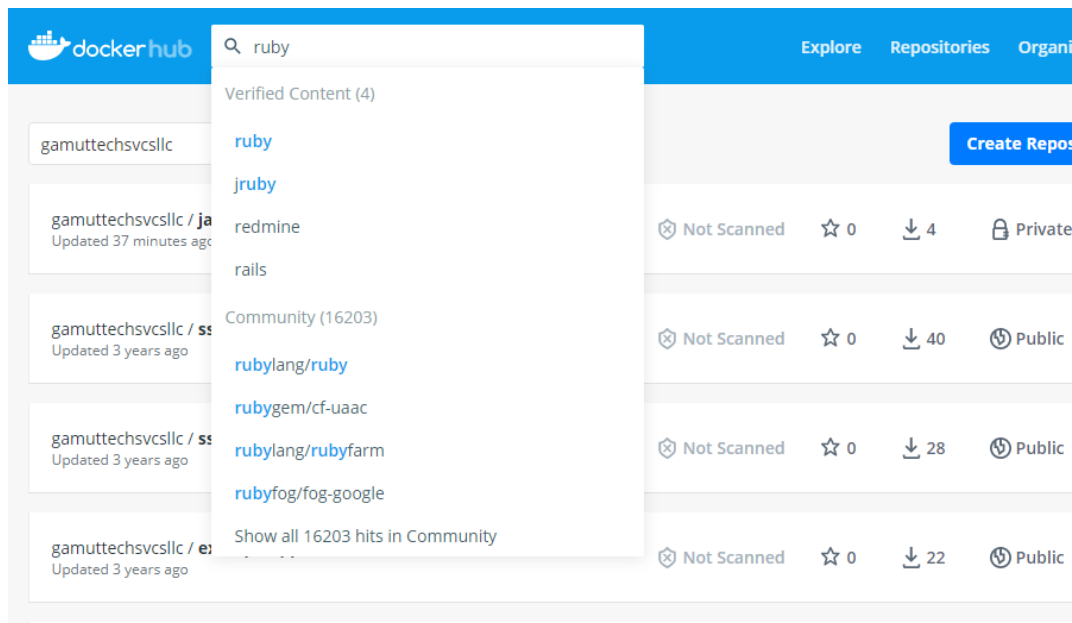
Docker Hub

- There are other registry types, including private registries

Docker Hub



Docker Hub



Docker Hub

The screenshot shows the Docker Hub interface with a search for 'ruby'. The top navigation bar is blue with the Docker Hub logo, a search bar containing 'ruby', and links for Explore, Repositories, Organizations, Get Help, and a user profile for 'gamuttechsvcsllc'. Below the navigation bar, there are tabs for Docker, Containers (which is selected), and Plugins. The main content area shows search results for 'ruby'. On the left, there are filters for Images, including 'Verified Publisher' and 'Official Images' (which is selected). Below these are categories for Analytics and Application Frameworks. The search results show 1 - 25 of 16,207 results for 'ruby'. The top result is the 'ruby' image, which is an official image. It has a download count of 10M+ and 2.0K stars. The image description states: 'Ruby is a dynamic, reflective, object-oriented, general-purpose, open-source programming language.' Below the description are tags for Container, Linux, 386, x86-64, ARM 64, IBM Z, mips64le, ARM, PowerPC 64 LE, and Programming Languages. The 'Official Image' badge is visible on the right side of the image card.

dockerhub

ruby

Explore Repositories Organizations Get Help gamuttechsvcsllc

Docker Containers Plugins

Filters

1 - 25 of 16,207 results for **ruby**. Clear search

Most Popular

Images

☐ Verified Publisher

☒ Official Images
Official Images Published By Docker

Categories

☐ Analytics

☐ Application Frameworks

ruby

Updated a day ago

Ruby is a dynamic, reflective, object-oriented, general-purpose, open-source programming language.

Container Linux 386 x86-64 ARM 64 IBM Z mips64le ARM PowerPC 64 LE Programming Languages

OFFICIAL IMAGE

10M+ 2.0K
Downloads Stars

OFFICIAL IMAGE

Docker Hub



ruby ☆

[Docker Official Images](#)

Ruby is a dynamic, reflective, object-oriented, general-purpose, open-source programming language.

↓ 100M+

Container

Linux

PowerPC 64 LE

386

x86-64

ARM 64

IBM Z

mips64le

ARM

Programming Languages

Official Image

Description

Reviews

Tags

Copy and paste to pull this image

```
docker pull ruby
```



[View Available Tags](#)

Docker Hub

How to use this image

Create a `Dockerfile` in your Ruby app project

```
FROM ruby:2.5

# throw errors if Gemfile has been modified since Gemfile.lock
RUN bundle config --global frozen 1

WORKDIR /usr/src/app

COPY Gemfile Gemfile.lock ./
RUN bundle install

COPY . .

CMD ["/your-daemon-or-script.rb"]
```

Put this file in the root of your app, next to the `Gemfile`.

You can then build and run the Ruby image:

```
$ docker build -t my-ruby-app .
$ docker run -it --name my-running-script my-ruby-app
```

Generate a `Gemfile.lock`



Building The Image

- To build the image from Dockerfile use *docker build*
- *docker build -t <tag name> <path to Dockerfile>*
- For example, *docker build -t java-demo .*
- Builds image from Dockerfile in current folder (.) with tag name “java-demo”



Building The Image

- For tag name, can include optional detail:
 - Docker ID in Docker Hub for eventual push to image registry
 - Version identifier for tag – defaults to “latest” if excluded
- For example, *docker build -t <docker ID>/<tag name>:<version> .*



Pushing/Pulling Image

- Use *docker push <docker ID>/<tag name>:<version>* to push to registry
- Use *docker pull <docker ID>/<tag name>:<version>* to pull from registry
- May prompt for credentials (e.g., Docker Hub login)



Pushing/Pulling Image

- To pull from public registry, use `docker pull <tag name>:<version>`
- For example, `docker pull openjdk:17`
- A `.dockerignore` file can be used to omit files/folders on push



Managing Images

- Use *docker images* to list available local images
- *--filter* argument enables wildcard search
- *docker images --filter=reference='<wildcard for tag name>:<wildcard for version>'*

Managing Images

```
MINGW64:/c/Users/a_san

a_san@DESKTOP-QJENT2P MINGW64 ~
$ docker images
REPOSITORY          TAG          IMAGE ID      CREATED        SIZE
java-demo            latest       0a7ca019beb0  58 minutes ago 468MB
gamuttechsvcsllc/java-demo  new-version  0a7ca019beb0  58 minutes ago 468MB
<none>              <none>      fe7f05ae9c   About an hour ago 468MB
openjdk              17          c765036142af  7 days ago    468MB

a_san@DESKTOP-QJENT2P MINGW64 ~
$ docker images --filter=reference='*/java*'
REPOSITORY          TAG          IMAGE ID      CREATED        SIZE
gamuttechsvcsllc/java-demo  new-version  0a7ca019beb0  About an hour ago 468MB

a_san@DESKTOP-QJENT2P MINGW64 ~
$ docker images --filter=reference='*java:*lat*'
REPOSITORY  TAG      IMAGE ID      CREATED        SIZE
java-demo   latest   0a7ca019beb0  About an hour ago 468MB

a_san@DESKTOP-QJENT2P MINGW64 ~
$
```



Managing Images

- To remove an image, use *docker rmi*
- *-f* argument used to remove images even when used by containers
- Can use *docker rmi -f <image ID>* to remove specific image



Managing Images

- Can use `docker rmi -f $(docker images -q)` to remove all (CAUTION)
- `docker images -q` lists images in quiet mode (returns image ID's only)

Managing Images

```
MINGW64/c/Users/a_san

a_san@DESKTOP-QJENT2P MINGW64 ~
$ docker images
REPOSITORY          TAG                 IMAGE ID            CREATED             SIZE
gamuttechsvcs11c/java-demo  new-version        0a7ca019beb0       About an hour ago  468MB
java-demo            latest             0a7ca019beb0       About an hour ago  468MB
<none>               <none>             fe7f05ae9c         About an hour ago  468MB
openjdk              17                 c765036142af       7 days ago         468MB

a_san@DESKTOP-QJENT2P MINGW64 ~
$ docker rmi -f 0a7ca019beb0
Untagged: gamuttechsvcs11c/java-demo:new-version
Untagged: gamuttechsvcs11c/java-demo@sha256:6769e87a7f5d86a79b7ea68ef1ee739bbff64fcec4a4fb89a657610efae9fdc9
Untagged: java-demo:latest
Deleted: sha256:0a7ca019beb0c5142f88f44a0e8f6f65e7f1ac5997b11afbda56005993f993d6

a_san@DESKTOP-QJENT2P MINGW64 ~
$ docker images
REPOSITORY          TAG                 IMAGE ID            CREATED             SIZE
<none>              <none>             fe7f05ae9c         About an hour ago  468MB
openjdk             17                 c765036142af       7 days ago         468MB

a_san@DESKTOP-QJENT2P MINGW64 ~
$ docker rmi $(docker images -q)
Deleted: sha256:fe7f05ae9c8c8df547d655b49d761bd7f0d308ed0ac6d00ce05f41088fa35b
Untagged: openjdk:17
Untagged: openjdk@sha256:eec9cfac4adce68e2f40d453b544ac722aac7e6be399aa7bc2f3eb32d0dea93b
Deleted: sha256:c765036142af5d6dec1f02119f61be06e43a9fcfed3ec2b3f465ec025f4be2cc

a_san@DESKTOP-QJENT2P MINGW64 ~
$ docker images
REPOSITORY          TAG                 IMAGE ID            CREATED             SIZE

a_san@DESKTOP-QJENT2P MINGW64 ~
$ |
```



Layers in a Docker Image

- Each instruction in a dockerfile makes a “layer”
- It’s actually a diff from the earlier layer
- Allows Docker to skip redundant info and use cached artifacts
- In this way, images themselves are actually diffs – they show what changed from the earlier stage (e.g., our app’s image is actually a diff from the base image you chose)



Best Practices for Creating Docker Images

- Single app per container
- Don't include unnecessary tools in your image (dev tools; network tools like netcat, etc.)
- Build as small an image as possible
 - Choose a small base image
 - Optimize your app for image size
- Use a consistent “tag” strategy
 - Document it
 - Use it for version info, testing strategy info, etc.
- Be smart about using public base images



Troubleshooting Docker Images

- Most common area is the Dockerfile
- Error on docker build has good messaging and an error code



Docker Containers

- Represent “runnable” instances of a docker image
- Application instance created from image in container can be used as:
 - Isolated executable
 - Request servicer (e.g., web listener)



Docker Containers

- Includes all dependencies and runtime defined by the image
- Isolated from other containers at the OS process layer
- Mechanisms exist to share resources across containers (e.g., files or DBs)
- However, isolation is what makes them powerful – avoid unnecessary coupling



Docker Containers

- Typically, containers are much smaller which makes them lightweight
- Quickly deployable and quick to “boot up”
- Isolation allows technologies like k8s to spin up multiple as needed
- “Load balancers” route to any of multiple instances using single point of connection



Creating Containers

- To create a new container, you can use *docker create*
- Multiple options are provided for configuring container (see *docker create --help*)
- For example, *docker create --name <container name> <image tag>*
- *<image tag>* defines image (template) from which to create container



Creating Containers

- To list available containers, use *docker ps*
- *docker ps -a* lists all containers (even those not currently started)
- Containers can be stopped and started



Creating Containers

- Use *docker start <name>* or *docker start <container ID>* to start
- Use *docker stop <name>* or *docker stop <container ID>* to stop
- Use *docker run* to create and start container in single step
- *docker run* is the more common command

Configuring Containers

- Command-line options for configuring containers using *docker run* include:
 - *--name* <container name> – give container user-defined name
 - *-p* <host port>:<container port> – map host port to container port for access
 - *-it* – indicates interactive on command-line (e.g., for gathering command-line input)
 - *--rm* – container automatically deleted when it exits or stops
 - *-d* – container runs in detached mode (e.g., for continually running web listeners)
- See *docker run --help* for additional info



Container Status

- Use *docker logs <container name>* to see log output from container
- Use *docker logs -f <container name>* for ongoing monitor of log output
- Helpful for troubleshooting issues with container creation, startup, or operation



Container Commands

- *docker exec* can be used to execute a command in a running container
- For example, *docker exec <container name> ls -a* to see container file contents
- *docker exec -it <container name> /bin/bash* for interactive command-line session in container (for Linux-based images that support bash)



Managing Containers

- *docker rm <container name>* or *docker rm <container ID>* removes container
- *-f* argument used to remove a running container
- Can use *docker rm -f \$(docker ps -aq)* to remove all (CAUTION)
- *docker ps -aq* lists all containers in quiet mode (returns container ID's only)

Data Storage in Docker

- Running containers generate data
- They may need access to “persistent” data
- We can use the host machine via a “bind mount” – mount a local file or folder into a container
 - Problems: Not easily managed by docker CLI
 - Rely on the host machine having a specific directory structure
- Better is to use a docker construct called a “volume”
 - New directory created in the host machine’s docker storage directory
 - Easier to back up
 - Work the same on both Linux and Windows containers
 - Can be safely shared between containers
 - Content can be pre-populated by the container



Common Docker Issues – How to Identify and Fix

- Dependency issues with base image:
 - RUN apt-get clean && apt-get update (clears cache in event base image has been updated in the registry)
- You may need to do this outside the container as well
- Container naming collisions:
 - If you try to use a container name that exists, you'll throw an error – EVEN if the container isn't being used. Remove it to use the name again.



Application Bootstrapping with Docker and k8s

- Kubernetes provides a hosting environment for containerized applications
- Once you have a Docker image, you can work entirely within Kubernetes to deploy your app



Open Container Initiative (OCI)

- The OCI is an open governance structure for the express purpose of creating open industry standards around container formats and runtimes
- Docker started it
- They have two specs: runtime-spec and image-spec
- This deals with containers in the abstract



Competing Container Runtimes

- rkt from CoreOS
- Mesos from Apache
- LXC Linux containers

Azure Container Registry (ACR)



Azure Container Registry (ACR)

<https://learn.microsoft.com/en-us/azure/container-registry/container-registry-intro>

ACR Tasks

<https://learn.microsoft.com/en-us/azure/container-registry/container-registry-tasks-overview>

<https://learn.microsoft.com/en-us/cli/azure/acr?view=azure-cli-latest#az-acr-create>

<https://learn.microsoft.com/en-us/cli/azure/acr?view=azure-cli-latest#az-acr-build>

<https://learn.microsoft.com/en-us/cli/azure/acr?view=azure-cli-latest#az-acr-run>

LAB:

ACR Tasks

Execute the “Hands-On” lab available at
https://github.com/KernelGamut32/azure_docker_microservices-public/tree/main/week02/labs/lab01

Azure Container Instances (ACI)



Azure Container Instances (ACI)

<https://learn.microsoft.com/en-us/azure/container-instances/container-instances-overview>

LAB:

ACI

Execute the “Hands-On” lab available at
https://github.com/KernelGamut32/azure_docker_microservices-public/tree/main/week02/labs/lab02

LAB:

Using Azure
Container
Instances

Execute the “Hands-On” lab available at
[https://github.com/KernelGamut32/azure_docker_microservices-
public/tree/main/week02/labs/lab03](https://github.com/KernelGamut32/azure_docker_microservices-public/tree/main/week02/labs/lab03)

LAB:

Containerized
Python with
MongoDB

Execute the “Hands-On” lab available at
[https://github.com/KernelGamut32/azure_docker_microservices-
public/tree/main/week02/labs/lab04](https://github.com/KernelGamut32/azure_docker_microservices-public/tree/main/week02/labs/lab04)

A decorative graphic consisting of a thick L-shaped line, with the horizontal part in pink and the vertical part in orange. To the right of this line, the background is filled with a grid of small white dots on a dark background.

Docker Compose



Docker Compose as a Dev Tool

- Used to run multi-container applications
- Declaratively configures your app's services as a unit
- All services can be started with one command

Docker Compose as a Dev Tool

- May require separate install
- To check for presence, run `docker-compose --version``
- To install:

```
1  #!/bin/bash
2  VERSION=$(curl --silent https://api.github.com/repos/docker/compose/releases/latest | grep -Po '"tag_name": "\K.*\d')
3  DESTINATION=/usr/local/bin/docker-compose
4  sudo curl -L https://github.com/docker/compose/releases/download/${VERSION}/docker-compose-$(uname -s)-$(uname -m) -o $DESTINATION
5  sudo chmod 755 $DESTINATION
6  docker-compose --version
```

Docker Compose as a Dev Tool

- docker-compose.yml used to define containers and relationships
- Uses YAML (Yet Another Markup Language)
- General format:

```
demos > docker-compose > 🐙 docker-compose.yml
1  ∨ container_name:
2    property: value
3    - or options
```




Docker Compose as a Dev Tool

- Supports all properties available with ``docker run``
- Uses a ``links`` property to link two containers together
- In it, specify required connections to existing container definition



Docker Compose as a Dev Tool

- Define secondary container(s) using same format
- Linked by identifier
- Multiple containers can be defined together in single YAML file



Docker Compose as a Dev Tool

- ``docker-compose up`` uses YAML file to launch all containers with one command
- Use ``docker-compose up <name>`` to bring up single container
- ``-d`` argument runs in background (similar to use with ``docker run``)



Docker Compose as a Dev Tool

- ``docker-compose ps`` displays details for all launched containers
- ``docker-compose logs`` display all logs for multi-container “unit”
- ``docker-compose scale web=#`` scales the number of web containers (use 1 to scale back down)



Docker Compose as a Dev Tool

- ``docker-compose stop`` to stop all containers
- ``docker-compose down`` or ``docker-compose rm`` to remove all containers
- See <https://docs.docker.com/compose/compose-file/>



Multi-stage Container Builds

- By setting a dependency in your Docker Compose file, you can make your multi-container app spin up in a specific order.

DEMO:

Docker Compose

Execute the “Hands-On” lab available at
https://github.com/KernelGamut32/azure_docker_microservices-public/tree/main/week02/demos/docker-compose

LAB:

Multi-Container
Group Using a
YAML File

Execute the “Hands-On” lab available at
[https://github.com/KernelGamut32/azure_docker_microservices-
public/tree/main/week02/labs/lab05](https://github.com/KernelGamut32/azure_docker_microservices-public/tree/main/week02/labs/lab05)

LAB:

Using Azure
Automated ML

Execute the “Hands-On” lab available at
https://github.com/KernelGamut32/azure_docker_microservices-public/tree/main/week02/labs/lab06

LAB:

Service Principal
Authentication
for ACR

Execute the “Hands-On” lab available at
[https://github.com/KernelGamut32/azure_docker_microservices-
public/tree/main/week02/labs/lab07](https://github.com/KernelGamut32/azure_docker_microservices-public/tree/main/week02/labs/lab07)



Thank you!

If you have additional questions,
please reach out to me at:
asanders@gamuttechnologysvcs.com



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