

CIS 371 Web Application Programming

Docker



Lecturer: **Dr. Yong Zhuang**

What is Docker?

- ❖ **What is Docker**
- ❖ **Virtual Machines vs Containers**
- ❖ **Docker Architecture and Workflow**
- ❖ **Installing Docker**
- ❖ **Development Workflow**

What is Docker?

A platform for **building**, **running**, and **shipping** applications.

What is Docker?

Situation: Your application works on your development machine but doesn't somewhere else. Why?



What is Docker?

Situation: Your application works on your development machine but doesn't somewhere else. Why?

- One or more files missing

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- One or more files missing
- Software version mismatch

What is Docker?

Situation: Your application works on your development machine but doesn't somewhere else. Why?

- **One or more files missing**
- **Software version mismatch**
- **Different configuration settings**

What is Docker?

Situation: Your application works on your development machine but doesn't somewhere else. Why?

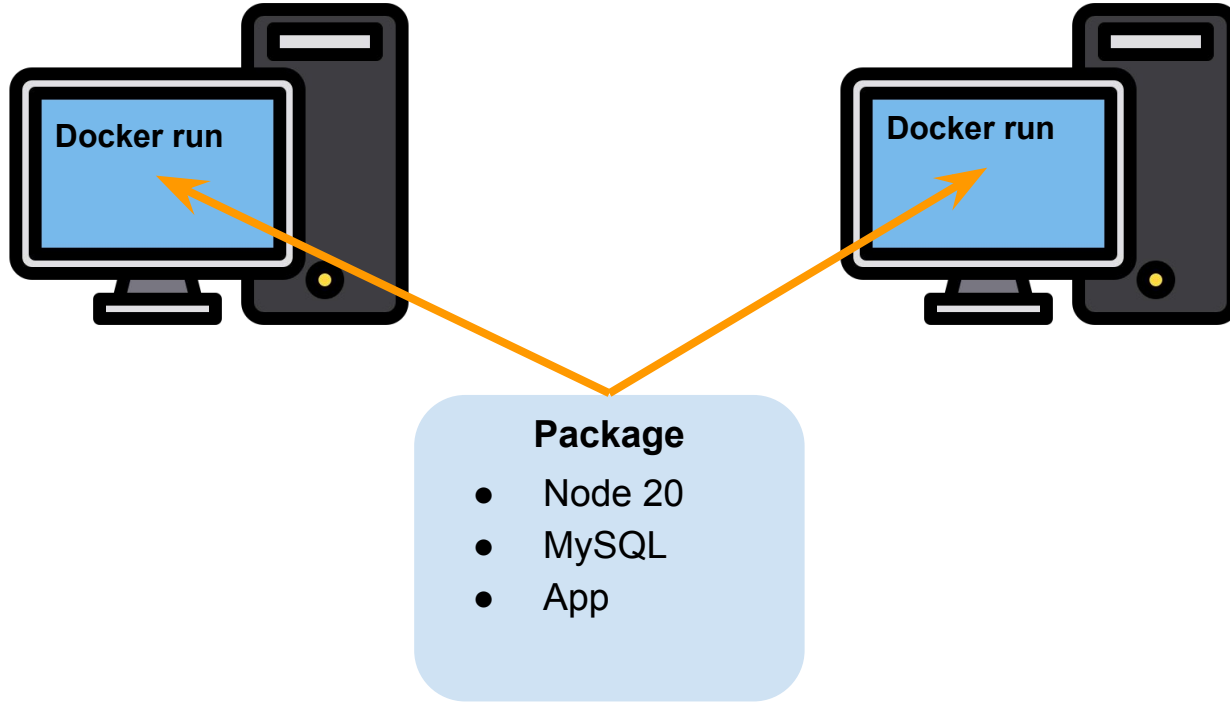
- One or more files missing
- Software version mismatch
- Different configuration settings



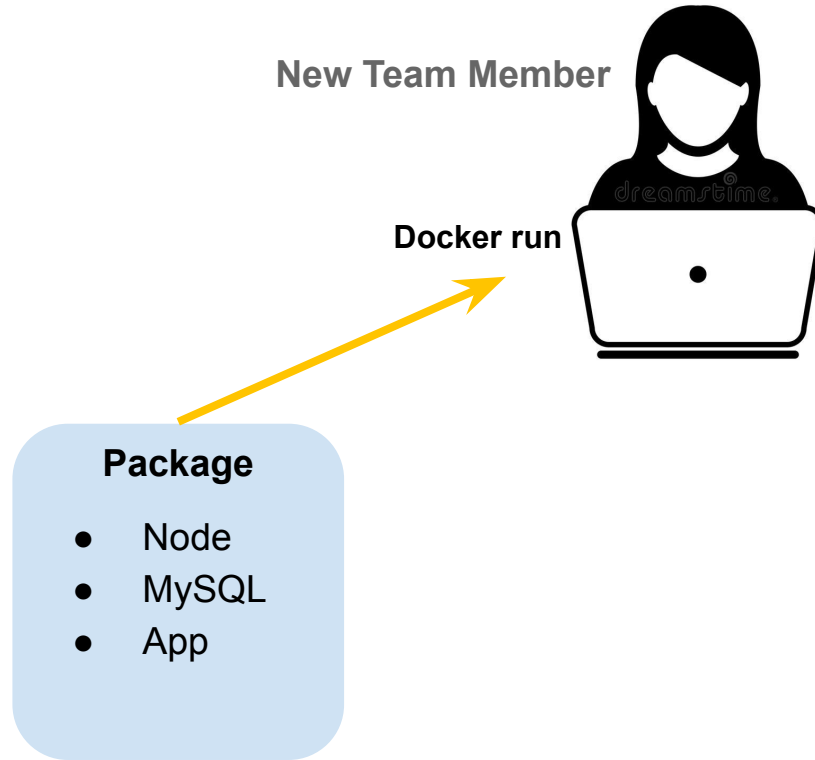
Advantage: Portability & Faster Deployments

Development Machine

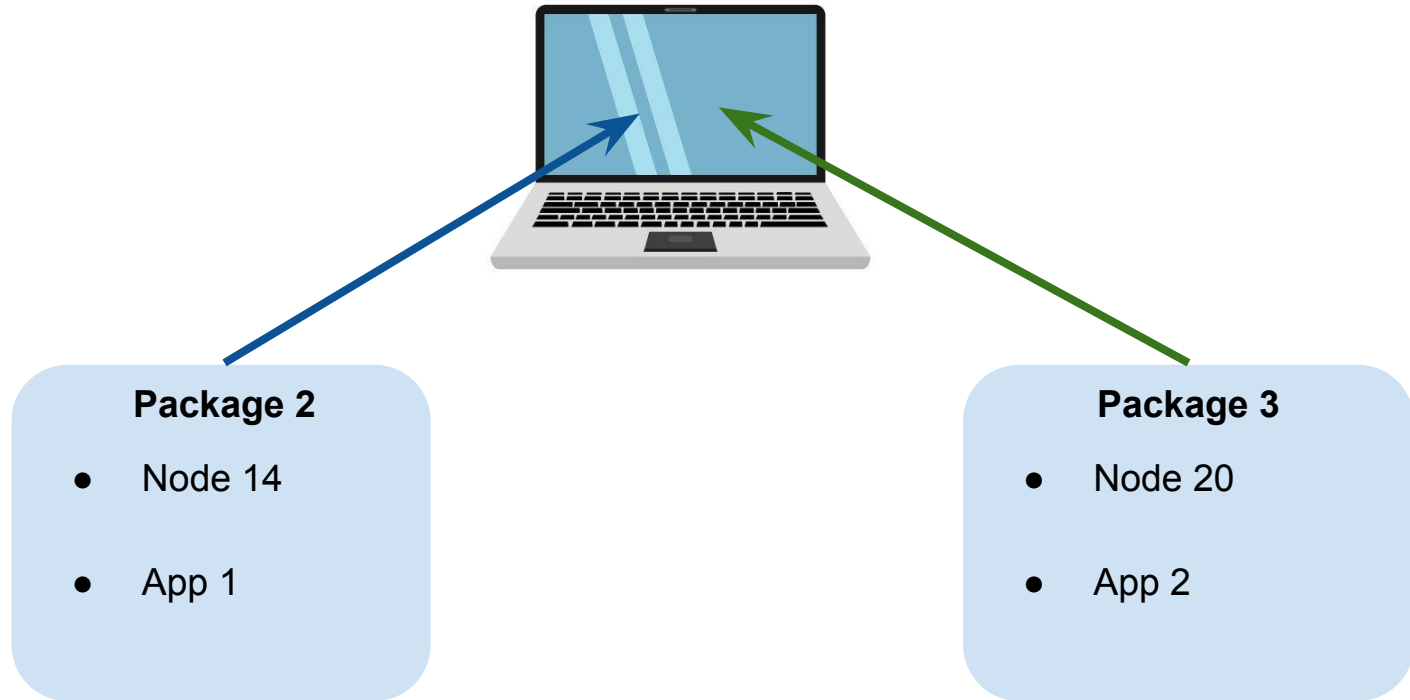
Test or Production Machine



Advantage: Sharing & Simplified Dependency



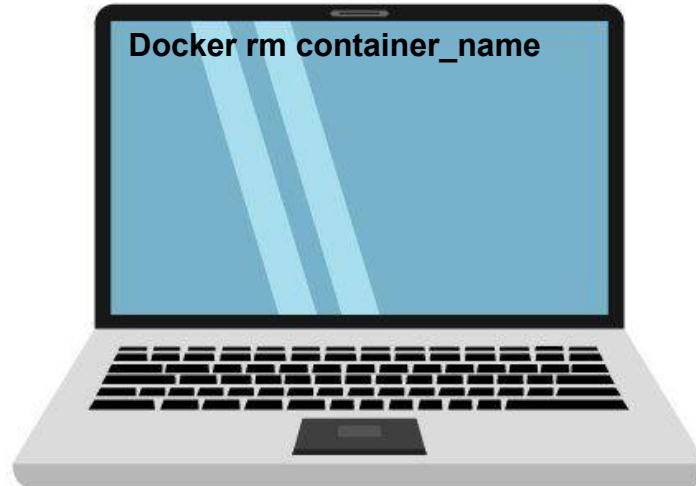
Advantage: Isolation & Security Sandbox



One more benefit



What is Docker?



What is Docker?

A platform for
Consistently
building, running, and shipping applications.



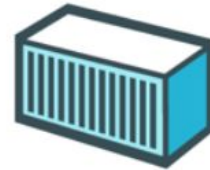
Build

Develop an app using Docker containers with any language and any toolchain.



Run

Scale to 1000s of nodes, move between data centers and clouds, update with zero downtime and more.



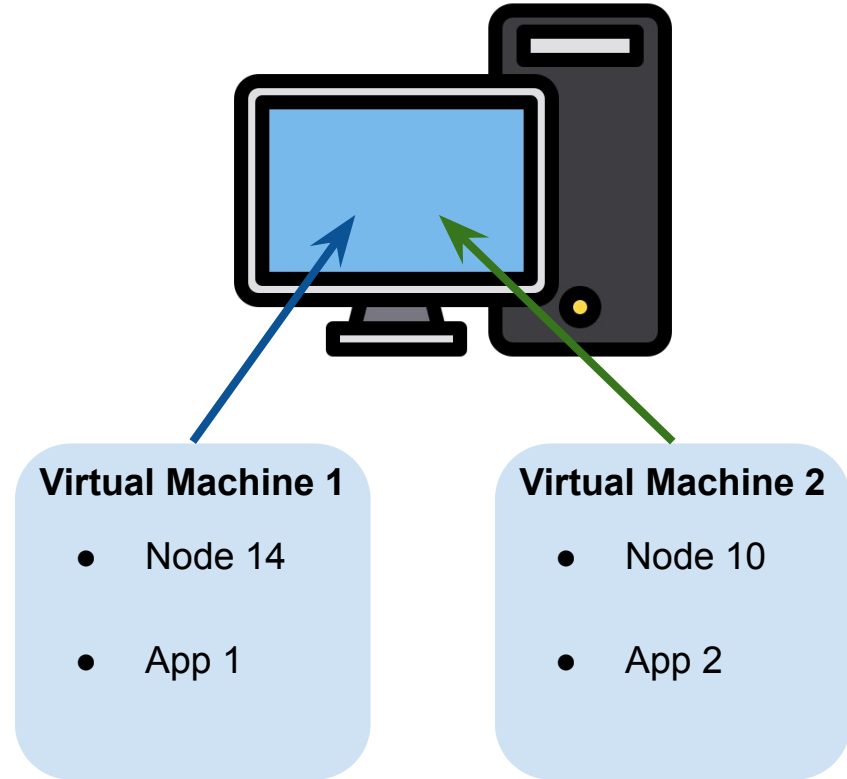
Ship

Ship the “Dockerized” app and dependencies anywhere - to QA, teammates, or the cloud - without breaking anything.

Virtual Machines

Virtual Machine

An abstraction of a machine
(physical hardware)



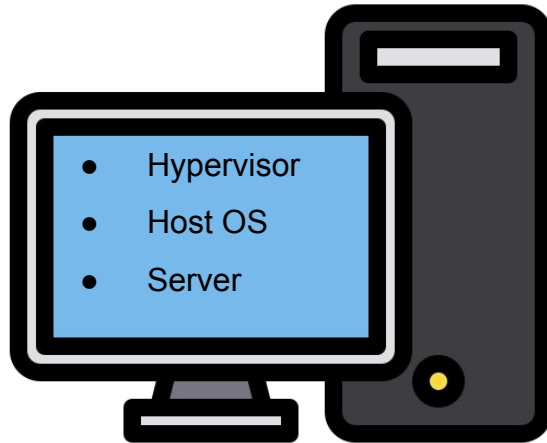
Virtual Machines

VM 1

- App 1
- Bins/Libs
- Guest OS

VM 2

- App 2
- Bins/Libs
- Guest OS



Problems

- Each VM needs a OS
- Slow to start
- Resource intensive

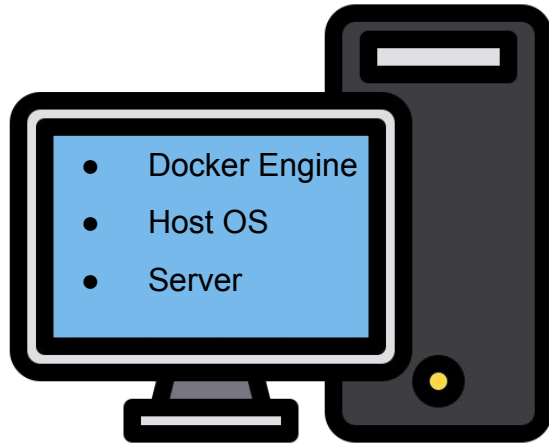
Docker Containers

Container 1

- App 1
- Bins/Libs

Container 2

- App 2
- Bins/Libs

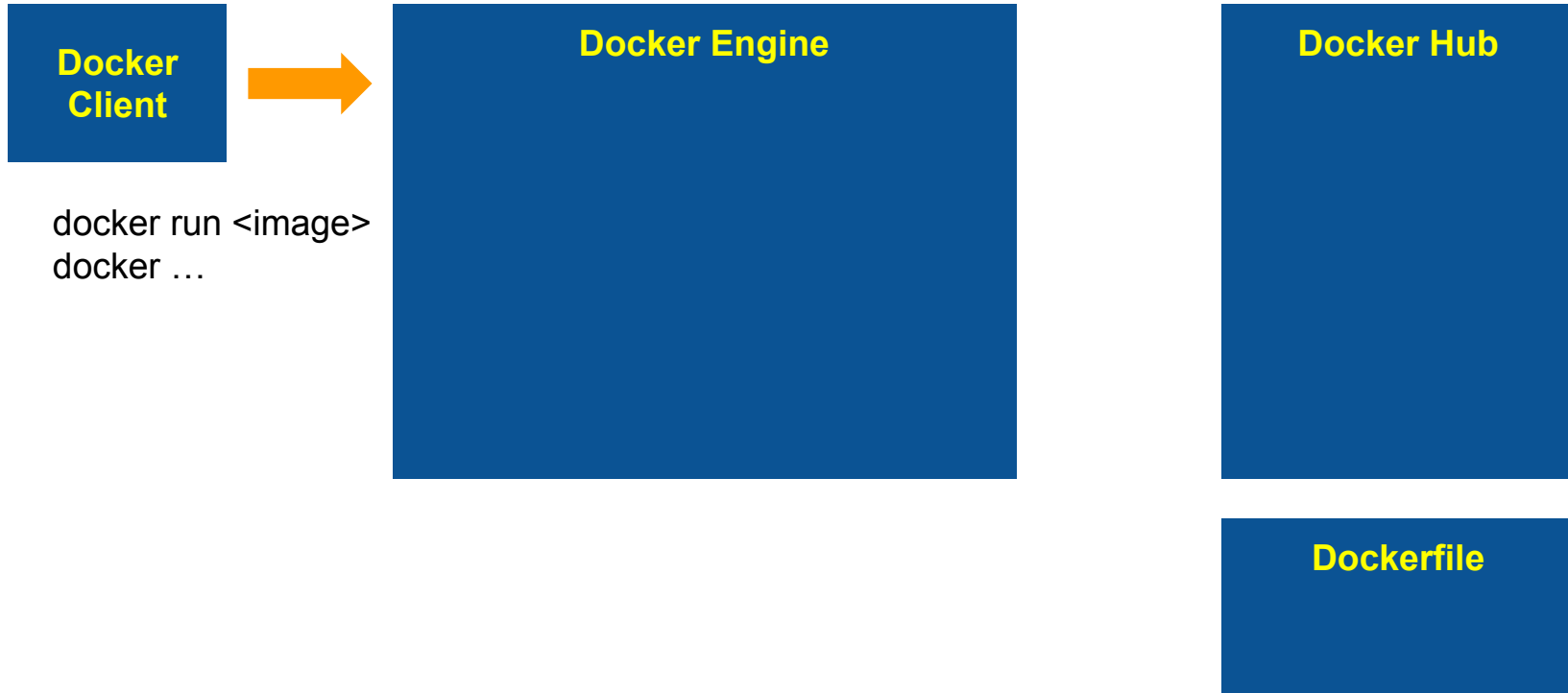


Docker Container

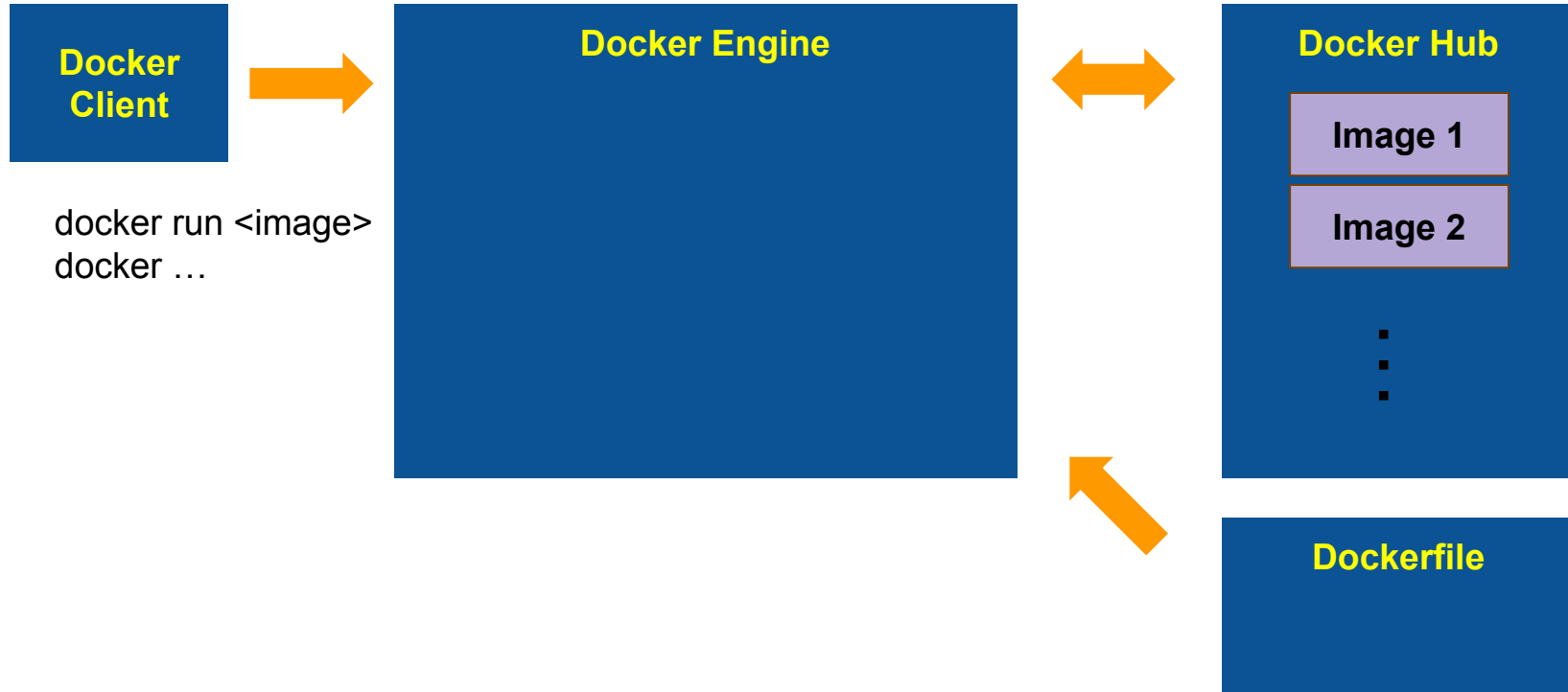
An isolated environment for running an application

- **Allow running multiple apps in isolation**
- **Are lightweight**
- **Use OS of the host**
- **Start quickly**
- **Need less hardware resources**

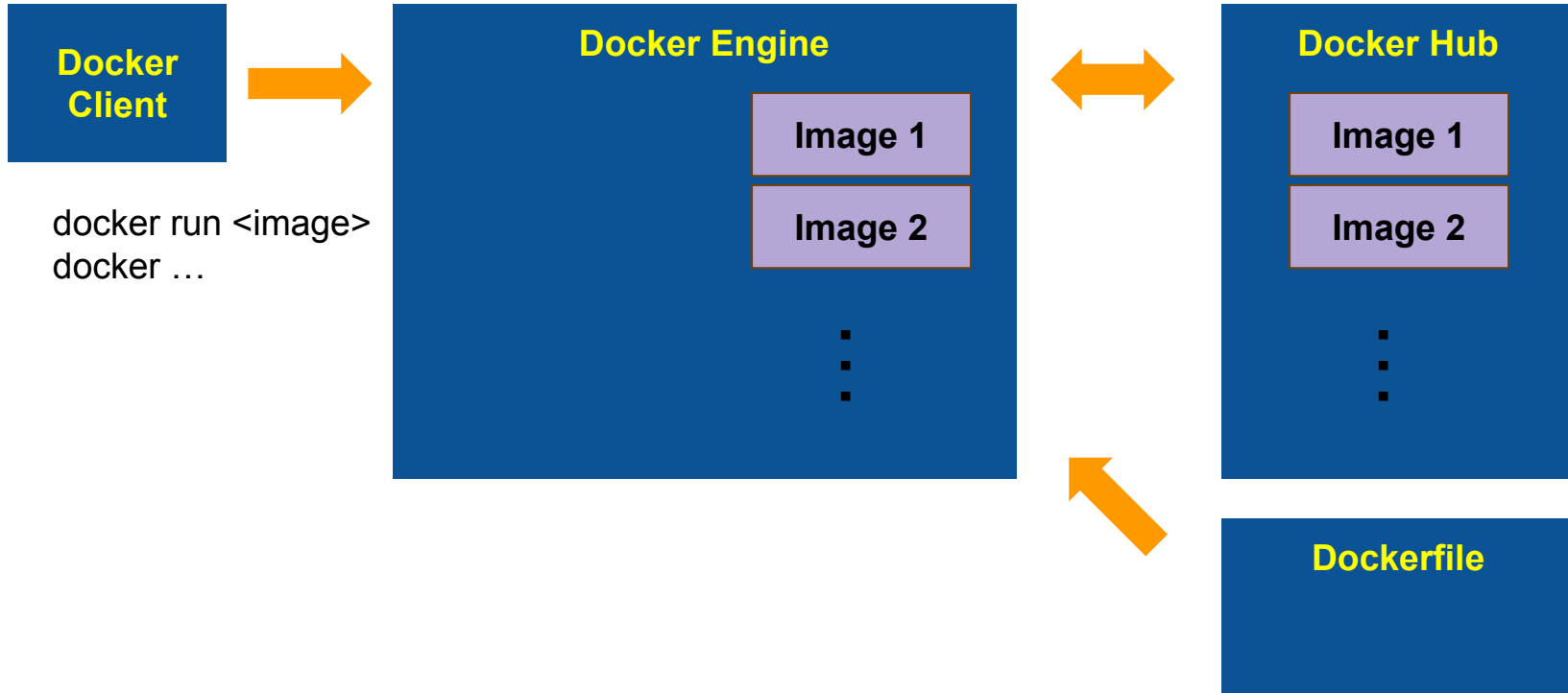
Docker Architecture and Workflow



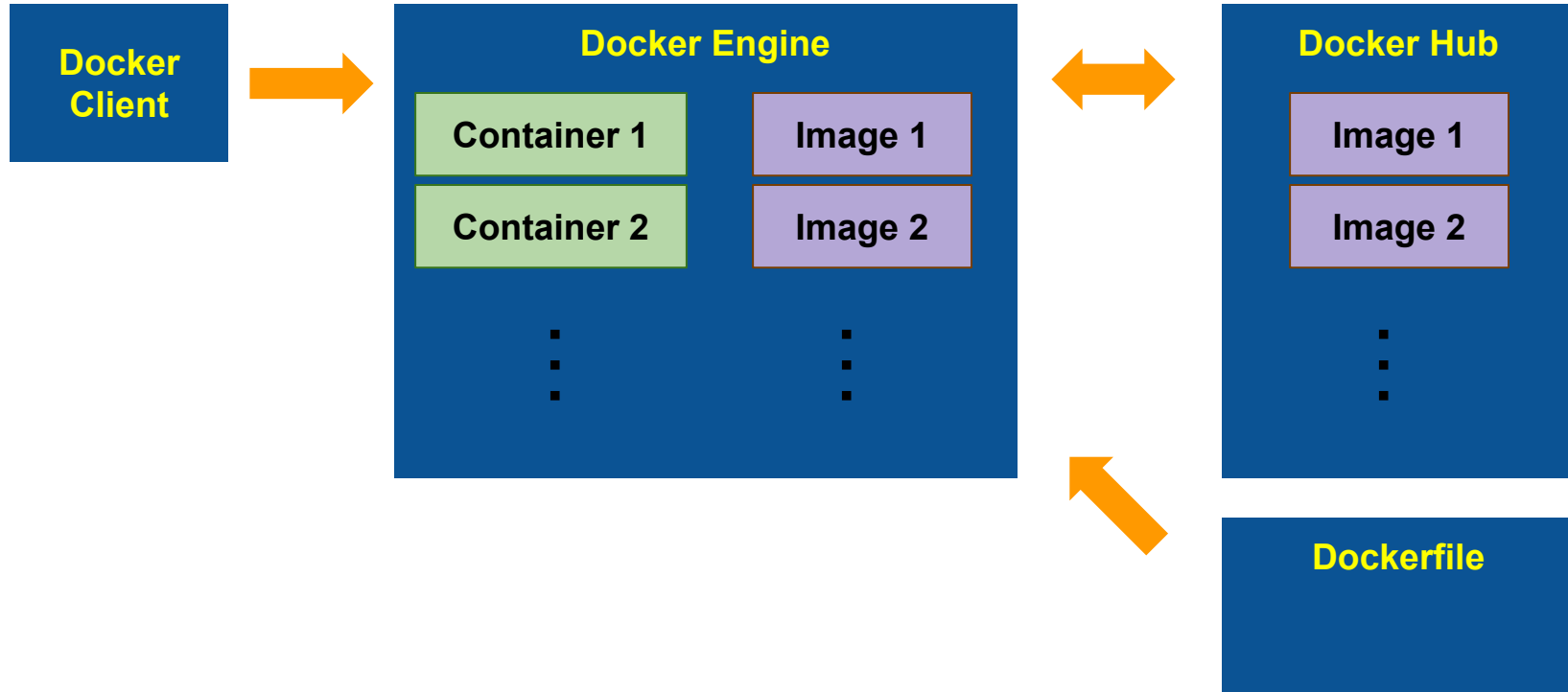
Docker Architecture and Workflow



Docker Architecture and Workflow



Docker Architecture and Workflow



Installing Docker

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Download for Mac - Apple Chip	↓
Download for Linux	↓

Get started

Installing Docker

<https://docs.docker.com/get-docker/>

The screenshot shows the Docker documentation website. The top navigation bar includes 'docker docs', 'Guides', 'Manuals', 'Reference', 'Samples', 'FAQ', and 'Contribute'. A search bar is on the right. The left sidebar lists 'Docker overview' and 'Get Docker' (highlighted). The main content area is titled 'Get Docker' and includes a breadcrumb 'Guides / Get Docker'. The text explains that Docker is an open platform for developing, shipping, and running applications, allowing users to separate applications from infrastructure. It mentions that Docker can significantly reduce the delay between writing code and running it in production. Below this, it states that Docker can be installed on multiple platforms. Three installation options are listed in boxes: 'Docker Desktop for Mac' (native macOS application), 'Docker Desktop for Windows' (native Windows application), and 'Docker Desktop for Linux' (native Linux application). On the right side of the page, there is a '1 minute read' indicator, links to 'Edit this page' and 'Request changes', and a 'Related content' section with links to 'Install Docker Desktop on Ubuntu', 'Install Docker Desktop on Mac', 'Docker overview', 'Install Docker Engine on Ubuntu', and 'Linux post-installation steps for Docker Engine'.

docker docs Guides Manuals Reference Samples FAQ Contribute Search

/ Guides / [Get Docker](#)

Get Docker

Docker is an open platform for developing, shipping, and running applications.

Docker allows you to separate your applications from your infrastructure so you can deliver software quickly. With Docker, you can manage your infrastructure in the same ways you manage your applications.

By taking advantage of Docker's methodologies for shipping, testing, and deploying code quickly, you can significantly reduce the delay between writing code and running it in production.

You can download and install Docker on multiple platforms. Refer to the following section and choose the best installation path for you.

Docker Desktop for Mac
A native application using the macOS sandbox security model which delivers all Docker tools to your Mac.

Docker Desktop for Windows
A native Windows application which delivers all Docker tools to your Windows computer.

Docker Desktop for Linux
A native Linux application which delivers all Docker tools to your Linux computer.

1 minute read

[Edit this page](#)

[Request changes](#)

Related content

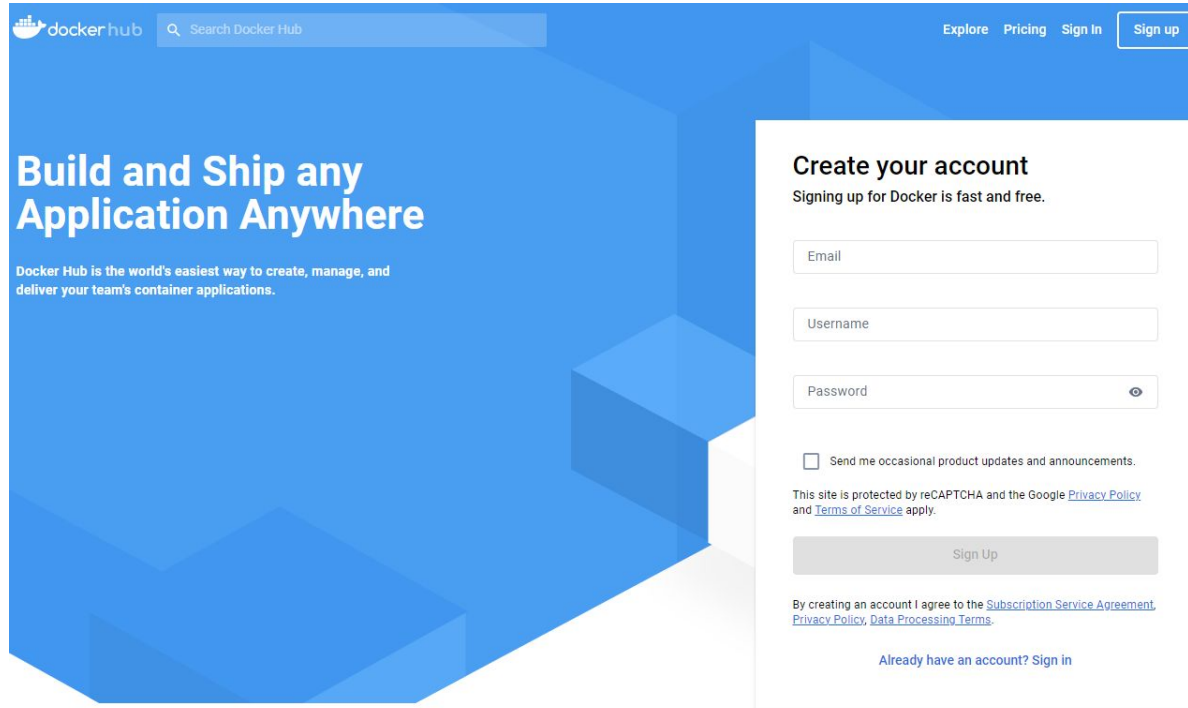
- [Install Docker Desktop on Ubuntu](#)
- [Install Docker Desktop on Mac](#)
- [Docker overview](#)
- [Install Docker Engine on Ubuntu](#)
- [Linux post-installation steps for Docker Engine](#)

Setup Videos

- [windows](#)
- [macOS](#)

Docker Hub

<https://hub.docker.com/>



The image shows the Docker Hub homepage. The background is blue with a large white text area on the left that says "Build and Ship any Application Anywhere". Below this, it says "Docker Hub is the world's easiest way to create, manage, and deliver your team's container applications." On the right, there's a white modal box titled "Create your account". Inside the modal, it says "Signing up for Docker is fast and free." and has input fields for "Email", "Username", and "Password". There's also a checkbox for "Send me occasional product updates and announcements." and a "Sign Up" button. At the bottom of the modal, it says "By creating an account I agree to the Subscription Service Agreement, Privacy Policy, Data Processing Terms." and "Already have an account? Sign in".

Build and Ship any Application Anywhere

Docker Hub is the world's easiest way to create, manage, and deliver your team's container applications.

Create your account
Signing up for Docker is fast and free.

Email

Username

Password

☐ Send me occasional product updates and announcements.

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Sign Up

By creating an account I agree to the [Subscription Service Agreement](#), [Privacy Policy](#), [Data Processing Terms](#).

Already have an account? [Sign in](#)

VS Code: Install Docker Extension



Verify your installation

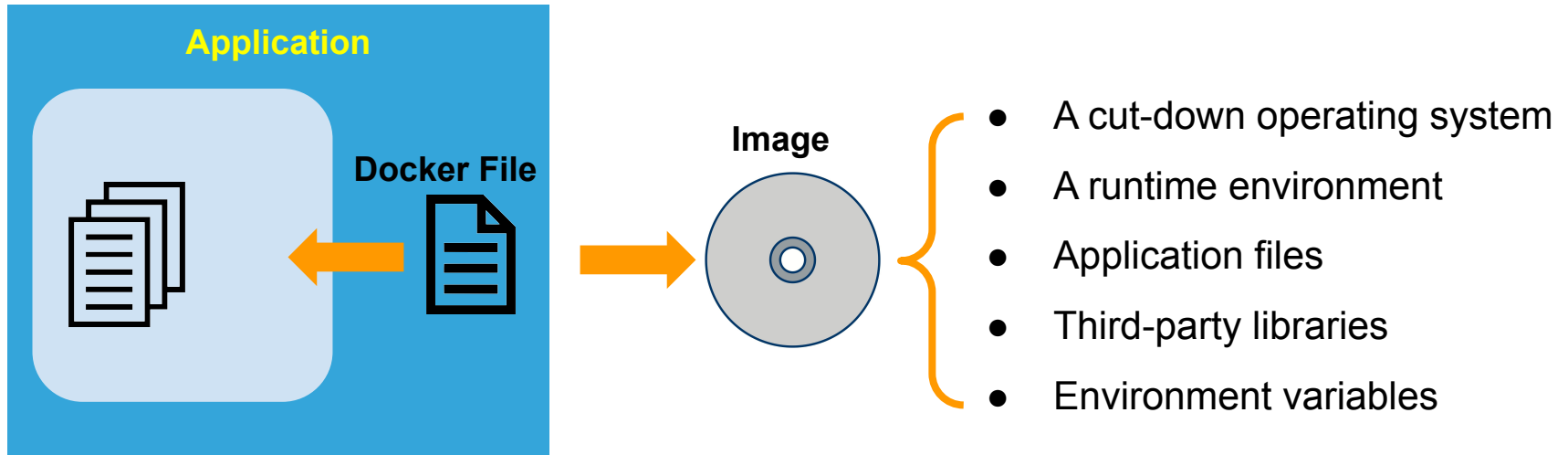
Open a terminal and run:

```
docker version
```

```
C:\Users\jazz1>docker version
Client:
 Cloud integration: v1.0.29
 Version:          20.10.22
 API version:      1.41
 Go version:       go1.18.9
 Git commit:       3a2c30b
 Built:            Thu Dec 15 22:36:18 2022
 OS/Arch:          windows/amd64
 Context:          default
 Experimental:     true

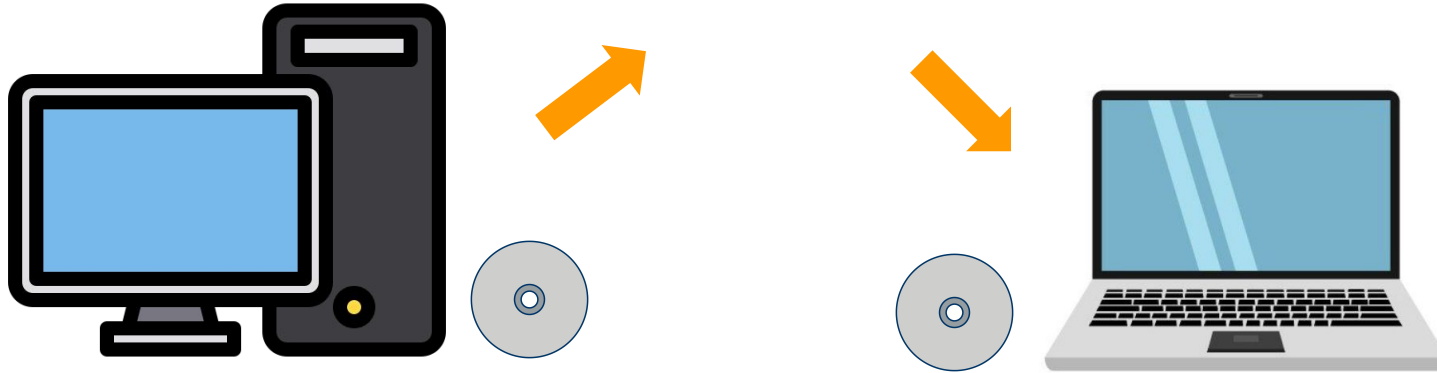
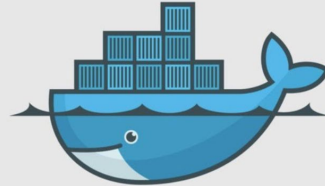
Server: Docker Desktop 4.16.3 (96739)
Engine:
 Version:          20.10.22
 API version:      1.41 (minimum version 1.12)
 Go version:       go1.18.9
 Git commit:       42c8b31
 Built:            Thu Dec 15 22:26:14 2022
 OS/Arch:          linux/amd64
 Experimental:     false
containerd:
 Version:          1.6.14
 GitCommit:        9ba4b250366a5ddde94bb7c9d1def331423aa323
runc:
 Version:          1.1.4
 GitCommit:        v1.1.4-0-g5fd4c4d
docker-init:
 Version:          0.19.0
 GitCommit:        de40ad0
```

Development Workflow



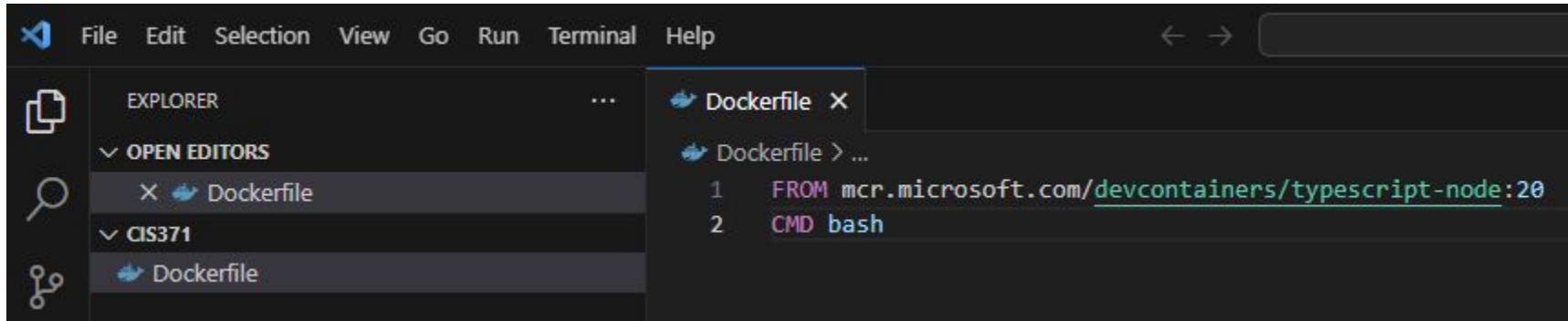
Development Workflow

Docker Hub



Example: Build NodeJS + TypeScript Env. Write Dockerfile

Docker image in Docker hub



The screenshot shows the Visual Studio Code interface. The Explorer sidebar on the left shows a file named 'Dockerfile' under the 'CIS371' folder. The main editor area displays the content of the 'Dockerfile' with two lines of code:

```
1 FROM mcr.microsoft.com/devcontainers/typescript-node:20
2 CMD bash
```

Microsoft Devcontainers

Best practices for writing Dockerfiles

Build Image

```
docker build -t your_dockerhub_id/docker_image_name .
```

```
PS C:\Users\jazz1\Documents\workspace\cis371> docker build -t jazz14jazz/cis371 .
[+] Building 47.1s (5/5) FINISHED
=> [internal] load build definition from Dockerfile
=> transferring dockerfile: 95B
=> [internal] load .dockerignore
=> transferring context: 28
=> [internal] load metadata for mcr.microsoft.com/devcontainers/base:ubuntu
=> [1/1] FROM mcr.microsoft.com/devcontainers/base:ubuntu@sha256:fdb79b61fb4e955b4042ddb25bbae616316984bcd46c193196c6e1664a5d367f
=> resolve mcr.microsoft.com/devcontainers/base:ubuntu@sha256:fdb79b61fb4e955b4042ddb25bbae616316984bcd46c193196c6e1664a5d367f
=> sha256:fdb79b61fb4e955b4042ddb25bbae616316984bcd46c193196c6e1664a5d367f 1.61kB / 1.61kB
=> sha256:bc84842d3d31ef92e5449d957cdc0156d76cc1a8333ba0166240ae57099f4d164 1.81kB / 1.81kB
=> sha256:46ddc7dc0a156bef047c96ac331fa66f1e1c47281920a72d11c0b8a9c3c08e66 8.85kB / 8.85kB
=> sha256:9d19ee268e0d7bcf6716e6658ee1b0384a71d6f2f9aa1ae2085610cf7c7b316f 30.43MB / 30.43MB
=> sha256:97966f3f03442a3d645f8354f49cc622b4416879f6c59142fab244ca2663677b 7.12MB / 7.12MB
=> sha256:f8b6dd6574d4a91e537f26304af811f5693269414c91a00fc33576be7fd4f72d 411B / 411B
=> sha256:cdb99b969289fd0b2bb0e466bece4169f9d93fb153bf0226c342c7bf0227174 135B / 135B
=> sha256:24c81fd0e0d521e7470ea8e587e4153624fdfed939c9f92bf8dd756a56071aca 224B / 224B
=> sha256:4c7fc7f7f0efb49ea8c582a361d123c443e16c047ec24efa6bc27858ba3a6d84 234B / 234B
=> sha256:2438dbb792cdae919eda60451a9838d269ed25bf3f5b974901f6fca01fc2c3 74.61MB / 74.61MB
=> sha256:9bd3ec670c1138bc6e45c0849a3a94a517c56d2143c046132076bdb90e1dd75b 149.75MB / 149.75MB
=> extracting sha256:9d19ee268e0d7bcf6716e6658ee1b0384a71d6f2f9aa1ae2085610cf7c7b316f
=> extracting sha256:97966f3f03442a3d645f8354f49cc622b4416879f6c59142fab244ca2663677b
=> extracting sha256:f8b6dd6574d4a91e537f26304af811f5693269414c91a00fc33576be7fd4f72d
=> extracting sha256:cdb99b969289fd0b2bb0e466bece4169f9d93fb153bf0226c342c7bf0227174
=> extracting sha256:24c81fd0e0d521e7470ea8e587e4153624fdfed939c9f92bf8dd756a56071aca
=> extracting sha256:4c7fc7f7f0efb49ea8c582a361d123c443e16c047ec24efa6bc27858ba3a6d84
=> extracting sha256:2438dbb792cdae919eda60451a9838d269ed25bf3f5b974901f6fca01fc2c3
=> extracting sha256:9bd3ec670c1138bc6e45c0849a3a94a517c56d2143c046132076bdb90e1dd75b
=> exporting to image
=> exporting layers
=> writing image sha256:bb947b3cf6187e99c3de07cac62c3087ba55d6570d82e874a770c817f77f6485
=> naming to docker.io/jazz14jazz/cis371
PS C:\Users\jazz1\Documents\workspace\cis371> docker images
```

REPOSITORY	TAG	IMAGE ID	CREATED	SIZE
jazz14jazz/cis371	latest	bb947b3cf618	5 weeks ago	661MB

Check Image

docker images

REPOSITORY	TAG	IMAGE ID	CREATED	SIZE
dockerhub_id/image_name	latest	1b971acc297e	5 weeks ago	1.68GB

Docker Desktop Update to latest Search for local and remote images, co... Ctrl+K

Images

Image is a read-only template with instructions for creating a Docker container. [Learn more](#)

Local Hub Artifactory **EARLY ACCESS**


7.34 GB / 12.99 GB in use 6 images Last refresh: about 2 hours ago

Search

<input type="checkbox"/>	Name	Tag	Status	Created	Size	Actions
<input type="checkbox"/>	jazz14jazz/cis371	latest	In use	about 1 month ago	1.67 GB	
	1b971acc297e					

Create a Container(Do This Once)

```
/* Create a container using docker run */  
docker run --name conatiner_name -it -v  
path_to_your_local_workspace:path_to_workspace_in_container your_dockerhub_id/docker_image_name  
root → / $
```



**Mount local workspace to
a workspace in the container.**

Some Docker commands

```
/* Check running containers */  
docker ps  
  
/* Check all containers */  
docker ps -a  
  
/* Start container */  
docker start container_name  
  
/* Stop container */  
docker stop container_name  
  
/* Re-enter a running container */  
docker exec -it container_name bash
```

Verify the NodeJS + TypeScript Env.

- node: for running JavaScript in a non-browser environment
- npm (Node Package Manager): for installing JS/TS libraries
- npx: Node package runner tool
- tsc: TypeScript Compiler

Verify the NodeJS + TypeScript Env.

```
/* Re-enter a running container */  
docker exec -it cis371 bash  
root → / $
```

```
/* Verify following installations in your container */  
root → / $ node -v  
v20.5.0  
root → / $ npm -v  
9.8.1  
root → / $ npx -v  
9.8.1  
root → / $ tsc -v  
Version 5.1.6
```

Push Docker Image to Dockerhub

```
docker push dockerhub_id/image_name
```

```
Using default tag: latest
```

```
The push refers to repository [docker.io/dockerhub_id/image_name]
```

```
b575e57f29c8: Pushed
```

```
bd96d63ee3b6: Pushed
```

```
f20b22c3fa07: Pushed
```

```
5f70bf18a086: Mounted from jupyter/datascience-notebook
```

```
63c178e39ea1: Pushed
```

```
cde4ef3850e2: Pushed
```

```
b578f477cd5d: Pushed
```

```
b298f9991a11: Pushed
```

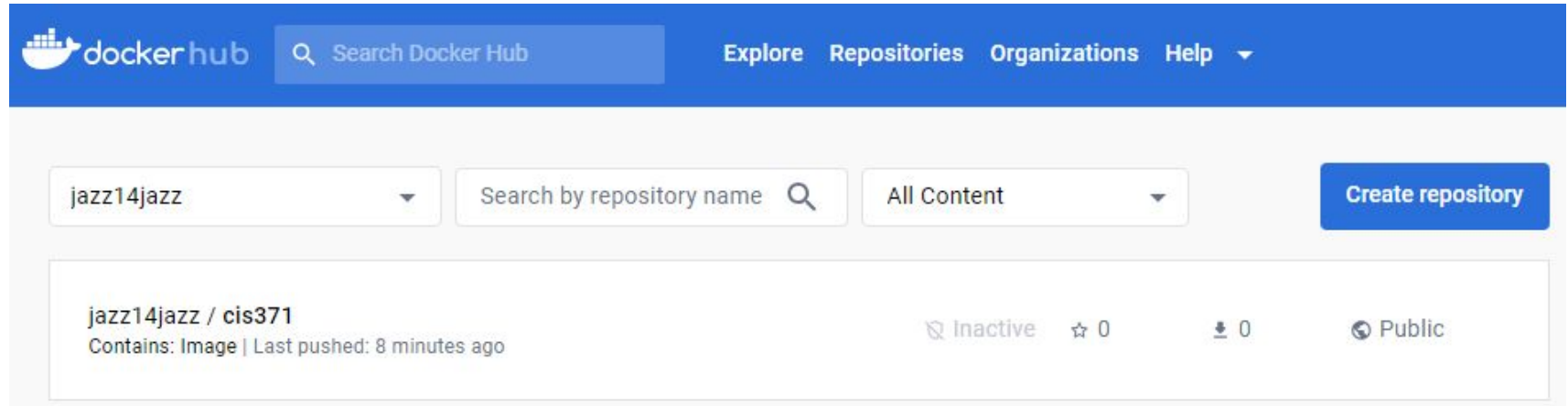
```
c94dc8fa3d89: Pushed
```

```
latest: digest:
```

```
sha256:e71aa9afb60fcb1c7f0b9223e349856dd52ca754502859726c8029422fa5bc3c size: 5141
```

Pull Docker Image

```
docker pull dockerhub_id/image_name
```



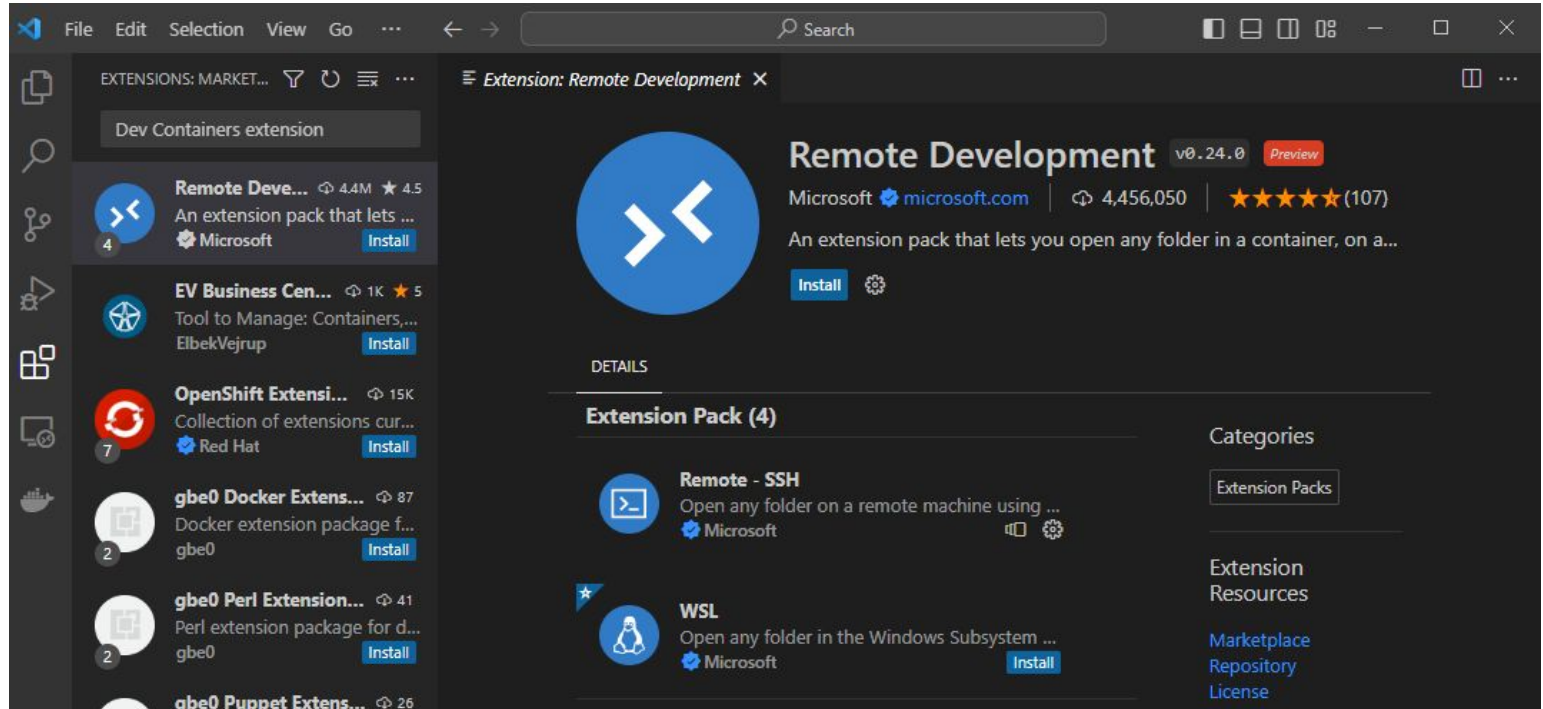
The screenshot shows the Docker Hub web interface. At the top is a blue navigation bar with the Docker Hub logo, a search bar labeled 'Search Docker Hub', and links for 'Explore', 'Repositories', 'Organizations', and 'Help'. Below the navigation bar is a search results section. It features a dropdown menu with 'jazz14jazz' selected, a search bar with the text 'Search by repository name', and another dropdown menu with 'All Content' selected. To the right of these is a blue button labeled 'Create repository'. Below the search bar, a repository entry is displayed: 'jazz14jazz / cis371'. Underneath this entry, it says 'Contains: Image | Last pushed: 8 minutes ago'. To the right of the repository name are icons and labels for 'Inactive', '0' stars, '0' downloads, and 'Public'.

More Docker Commands

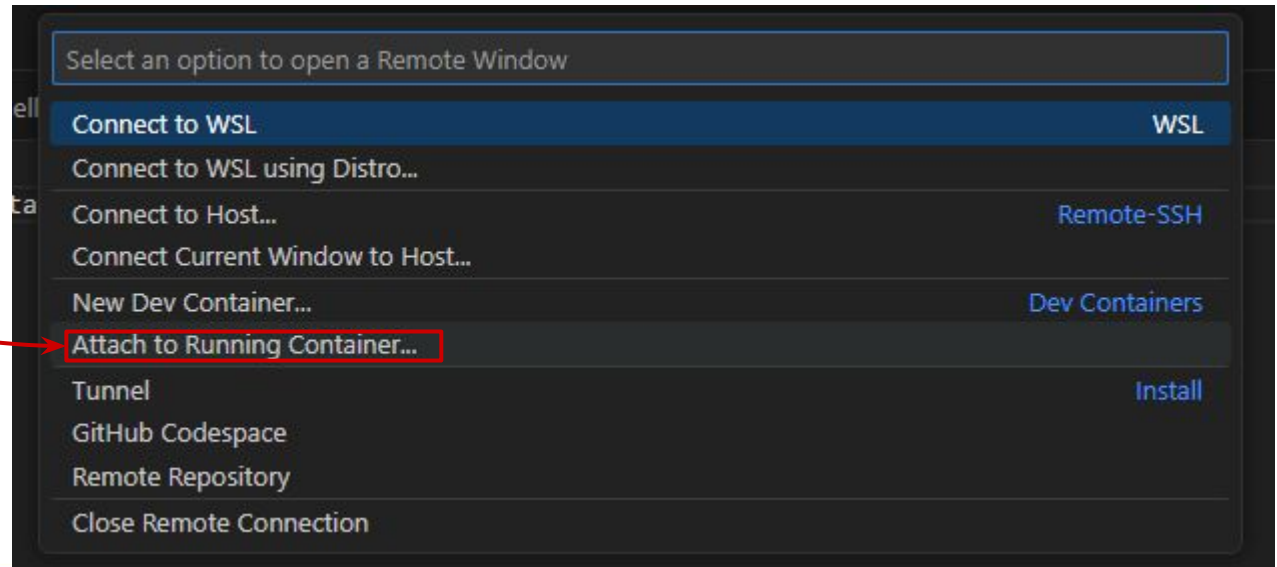
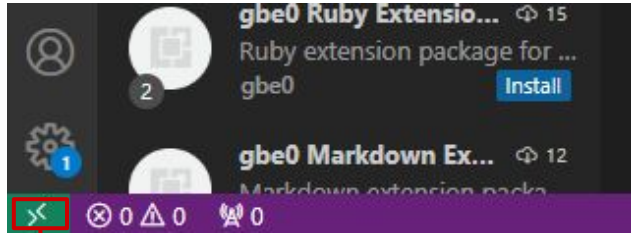
[All Commands](#)

[Cheat Sheet](#)

VS Code: Install Remote Development Extension



VS Code: Open the container in VS Code



VS Code: Open a terminal in VS Code

