

CIS 371 Web Application Programming

Docker



GRAND VALLEY
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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**

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**

What is Docker?

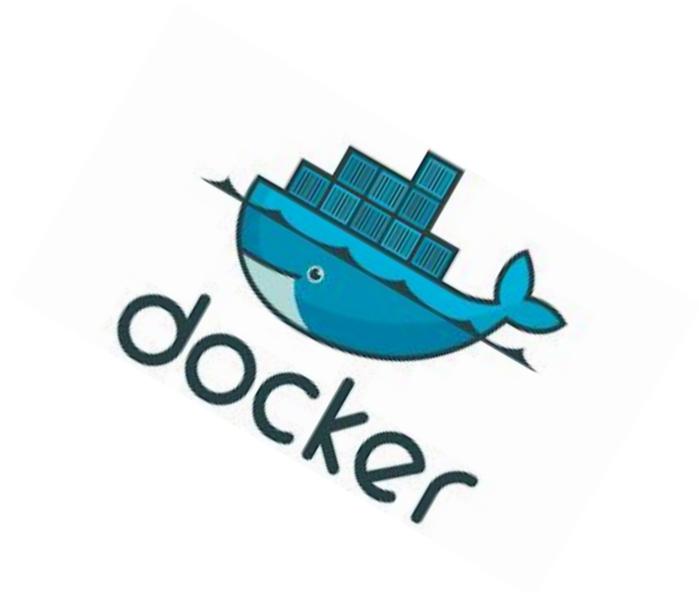
Situation: Your application works on your development machine but doesn't somewhere else. Why?

- **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?

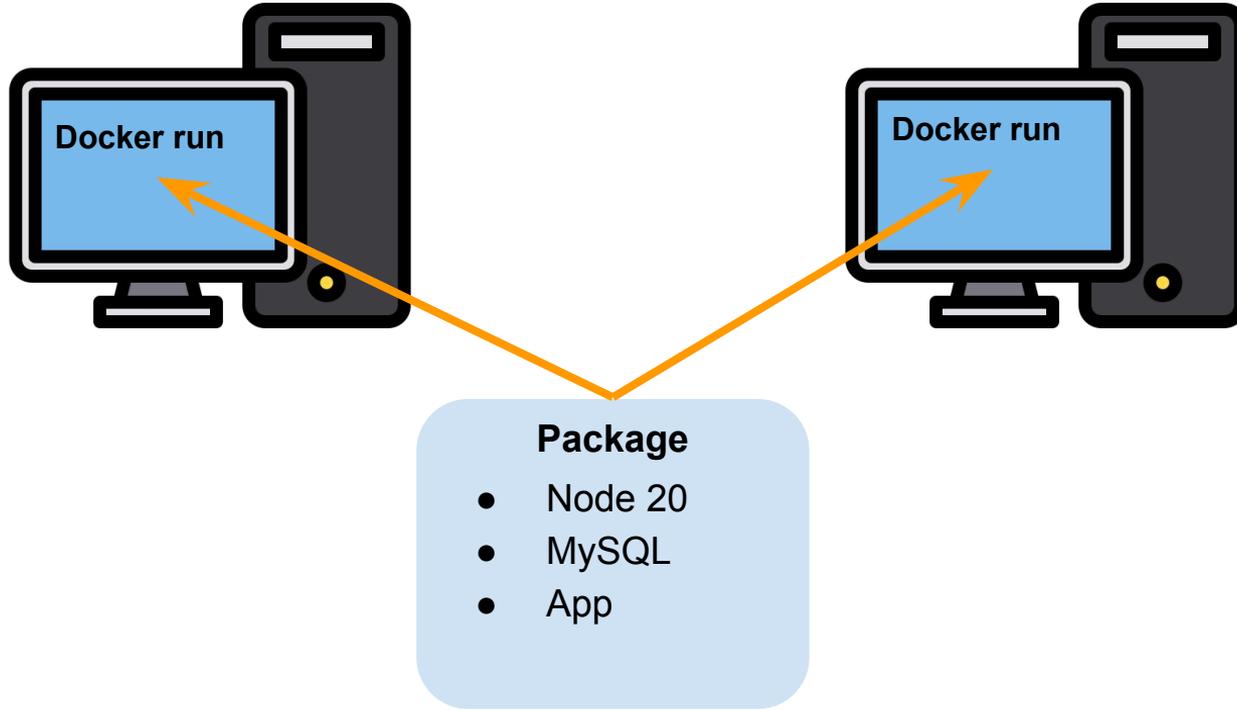
- One or more files missing
- Software version mismatch
- Different configuration settings



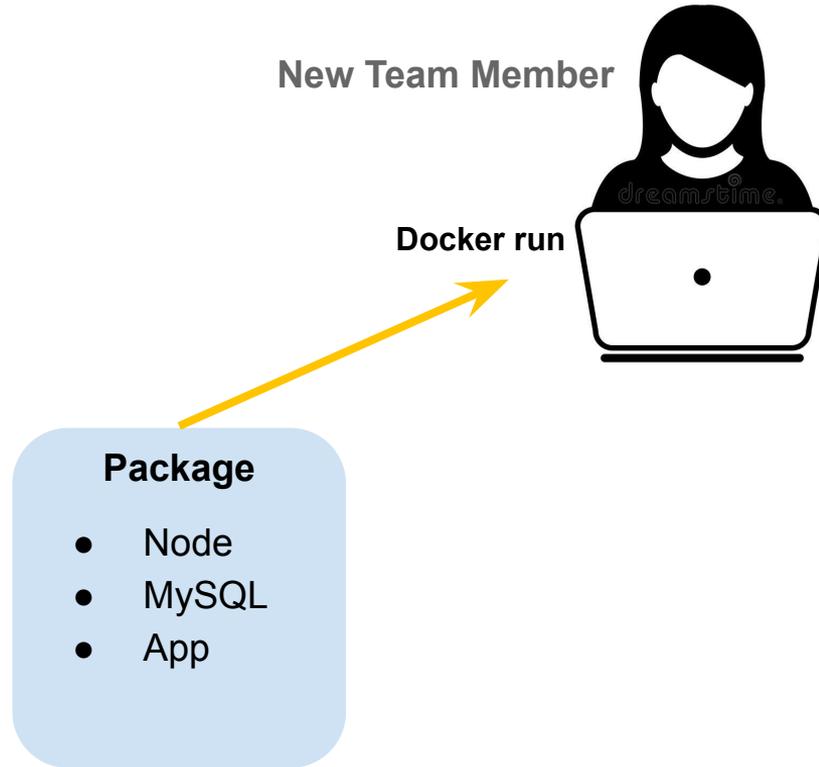
Advantage: Portability & Faster Deployments

Development Machine

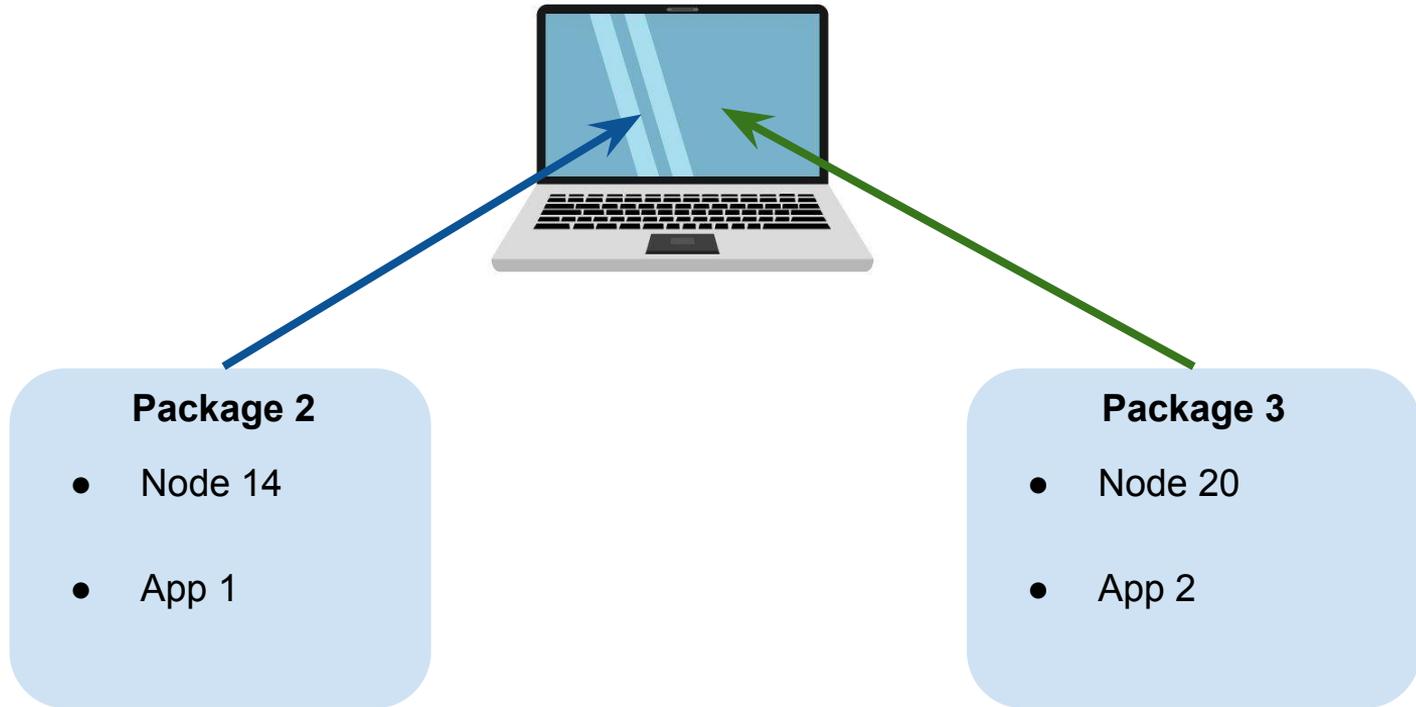
Test or Production Machine



Advantage: Sharing & Simplified Dependency



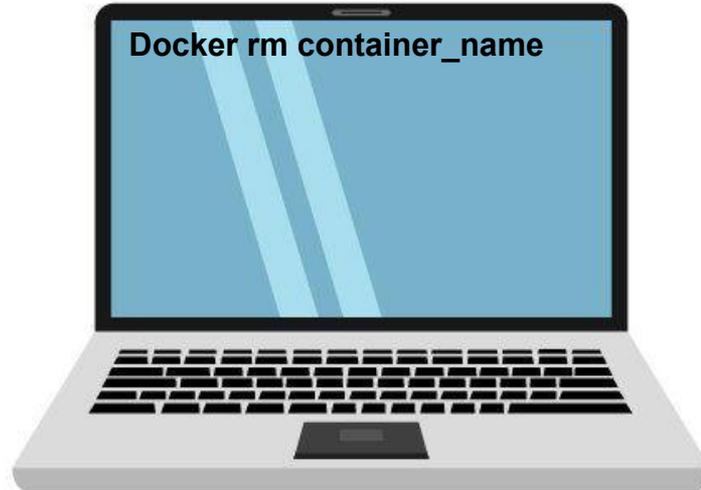
Advantage: Isolation & Security Sandbox



One more benefit



What is Docker?



What is Docker?

A platform for

Consistently

building, running, and shipping applications.



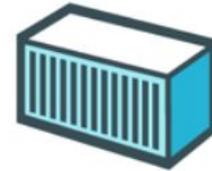
Build

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.



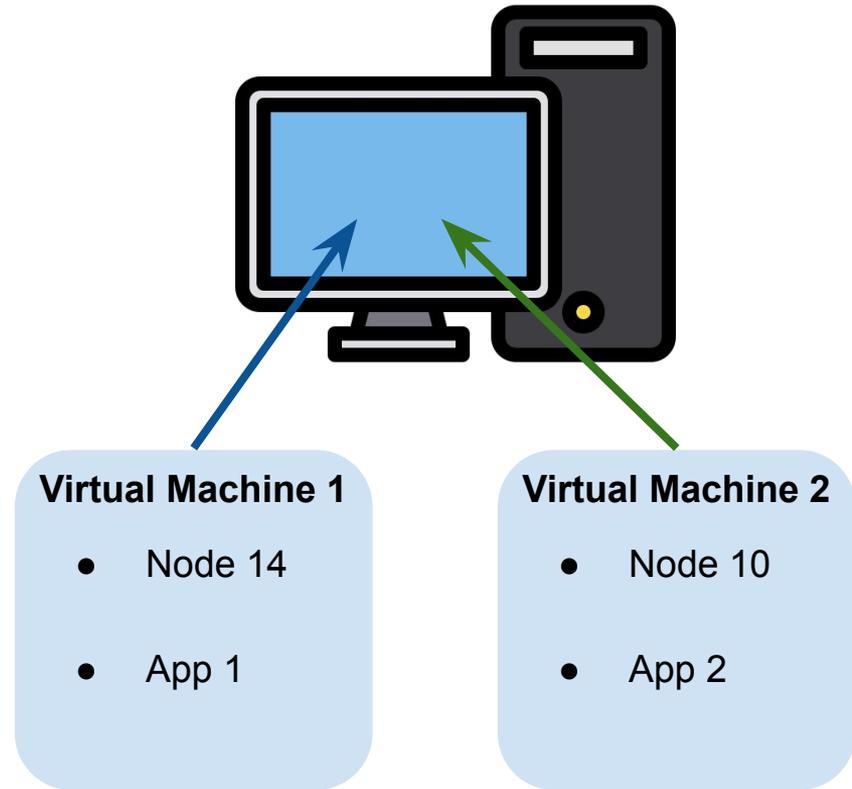
Ship

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)



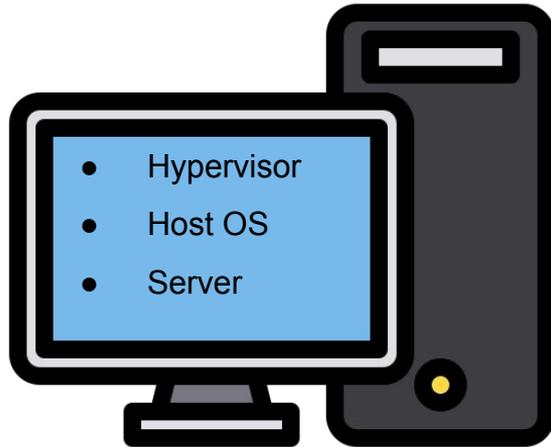
Virtual Machines

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**

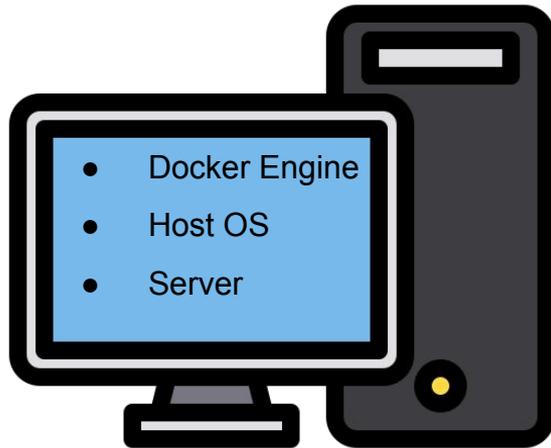
Docker Containers

Container 1

- App 1
- Bins/Libs

Container 2

- App 2
- Bins/Libs

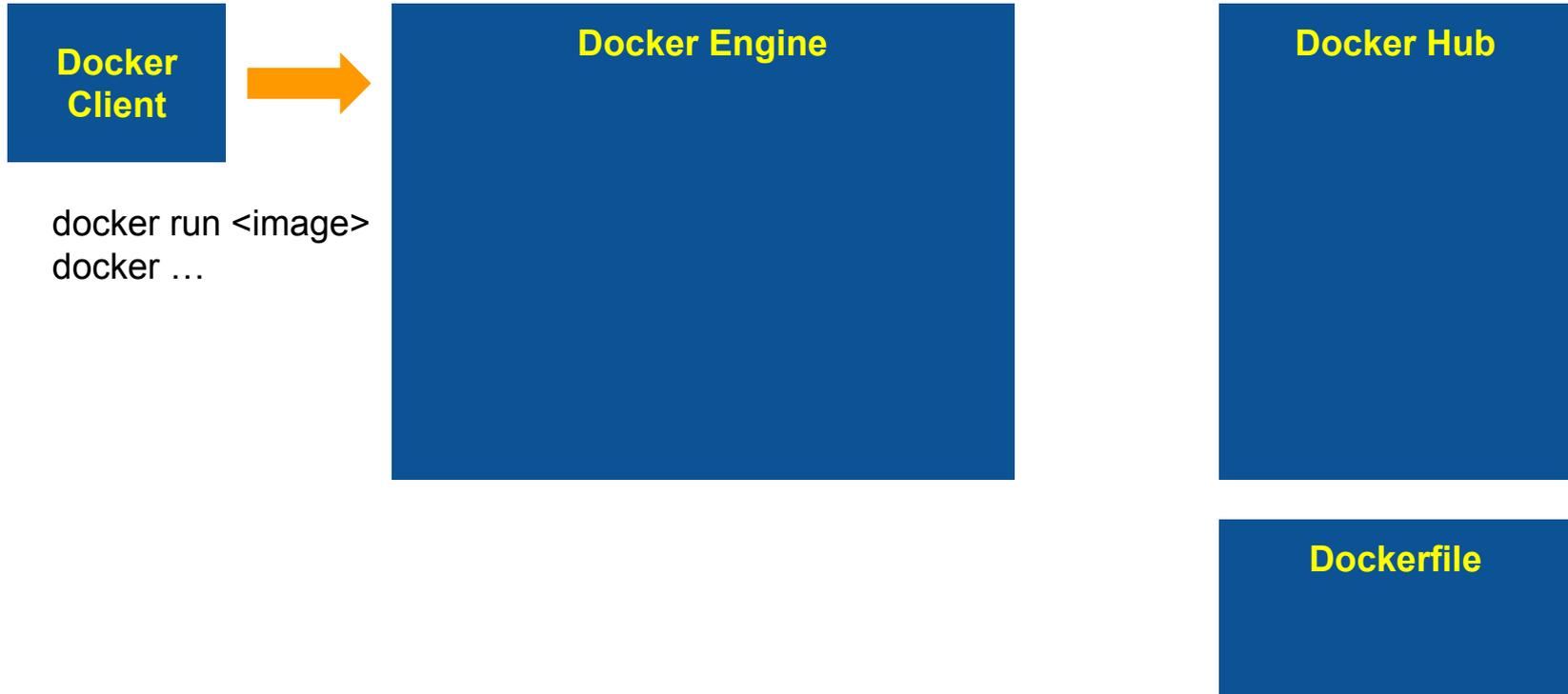


Docker Container

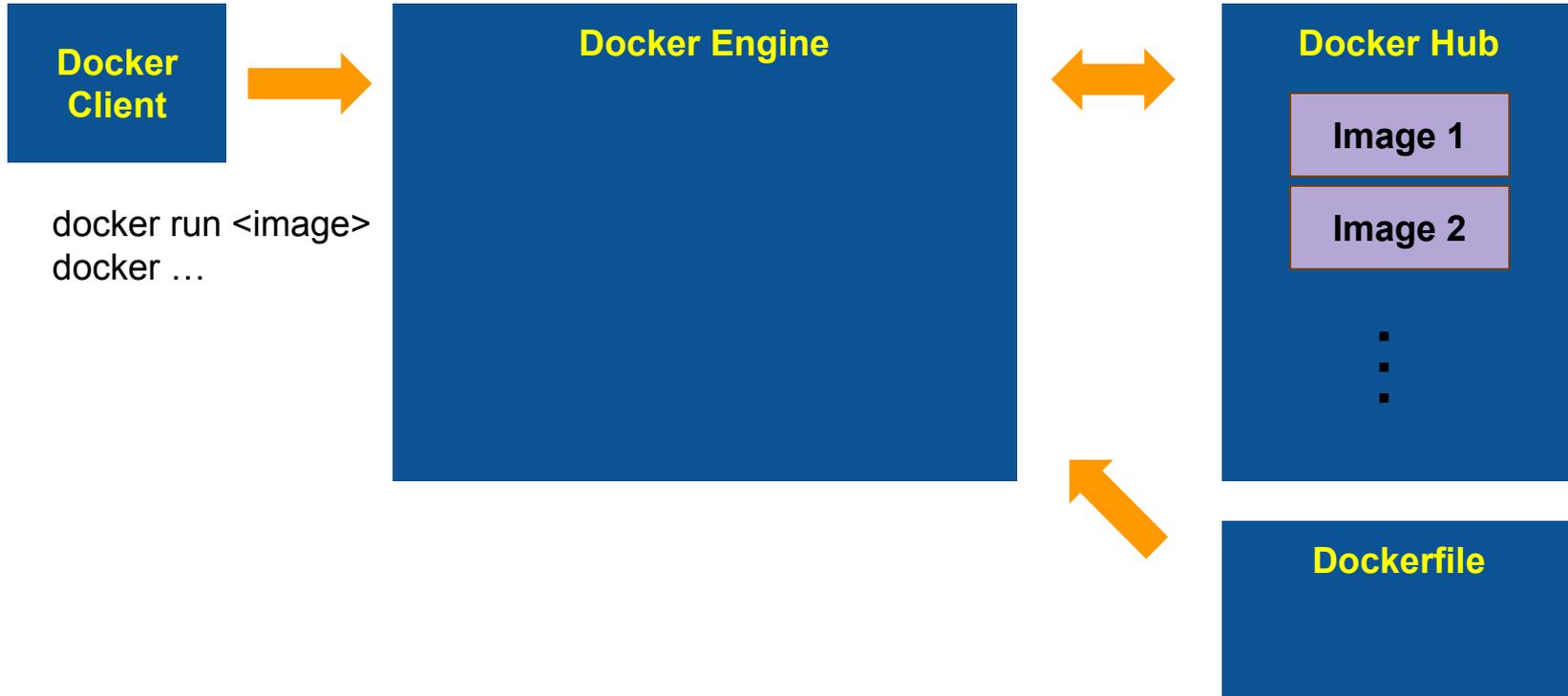
An isolated environment for running an application

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

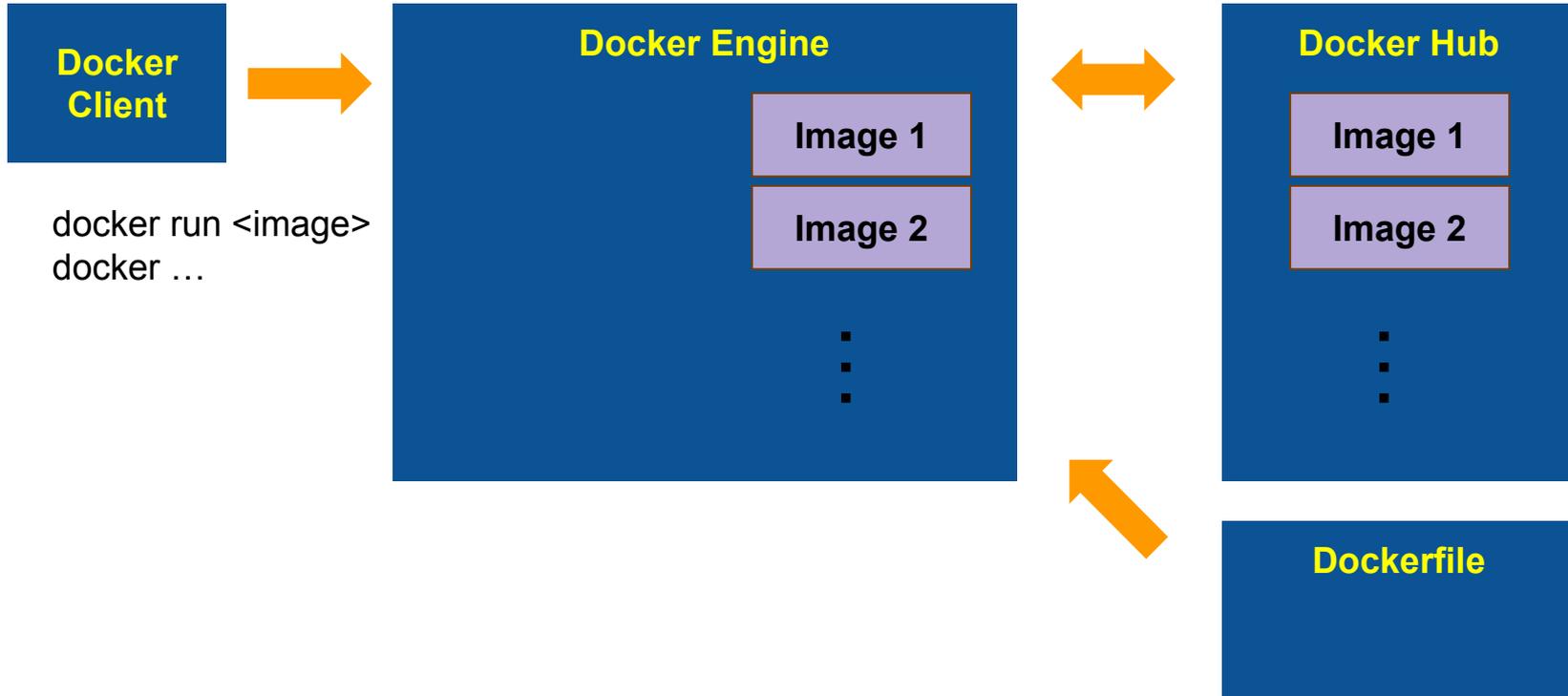
Docker Architecture and Workflow



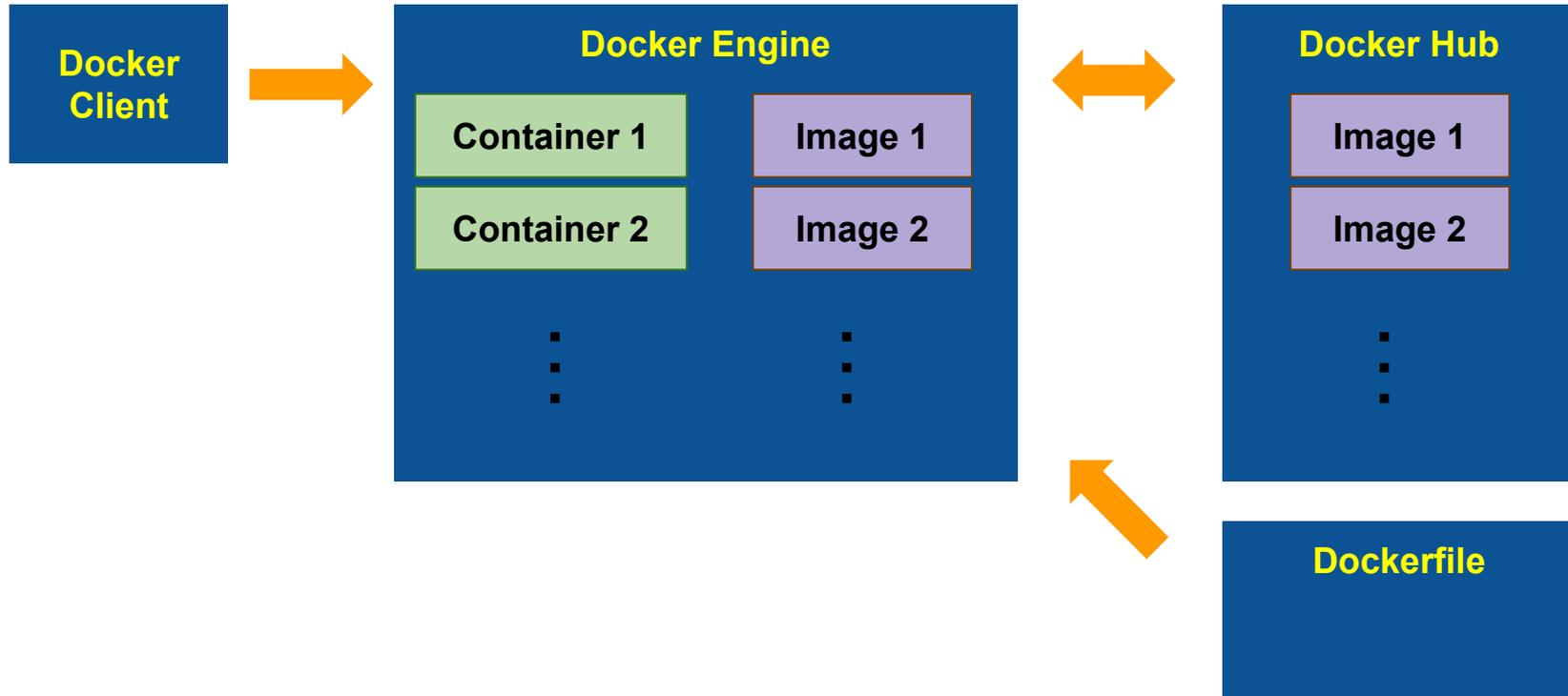
Docker Architecture and Workflow



Docker Architecture and Workflow



Docker Architecture and Workflow



Installing Docker

docker.com



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Get Started

Develop faster. Run anywhere.

The most-used tool in Stack Overflow's [2023 Developer Survey](#).

Download for Windows	↓
Download for Mac - Intel Chip	↓
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 contains the following text:

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.

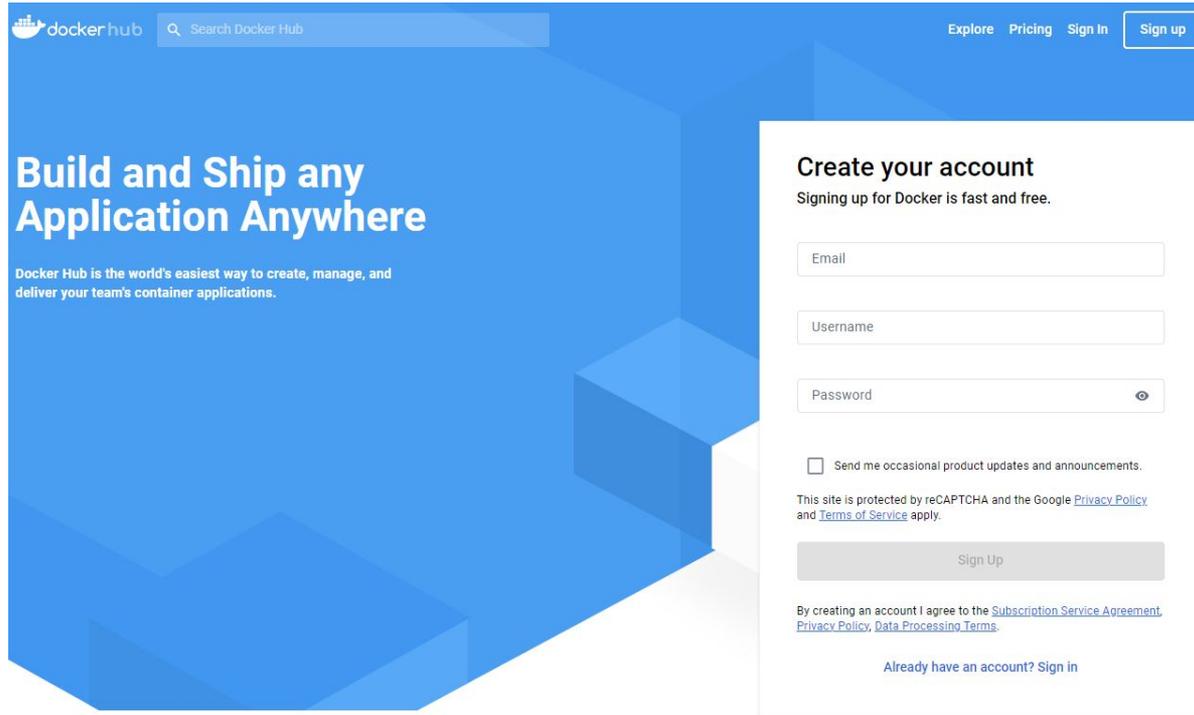
On the right side of the page, there is a '1 minute read' indicator, 'Edit this page' and 'Request changes' links, and a 'Related content' section with links to 'Install Docker Desktop on Ubuntu', 'Install Docker Desktop on Mac', 'Docker overview', 'Install Docker Engine on Ubuntu', and 'Linux post-installation steps for Docker Engine'.

Setup Videos

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

Docker Hub

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



The screenshot shows the Docker Hub website interface. At the top left is the Docker Hub logo and a search bar. On the top right are links for 'Explore', 'Pricing', 'Sign In', and a 'Sign up' button. The main content area features a large blue background with the text 'Build and Ship any Application Anywhere' and a sub-headline: 'Docker Hub is the world's easiest way to create, manage, and deliver your team's container applications.' On the right side, there is a white 'Create your account' form. The form includes input fields for 'Email', 'Username', and 'Password'. Below the password field is a checkbox for 'Send me occasional product updates and announcements.' A note states: 'This site is protected by reCAPTCHA and the Google Privacy Policy and Terms of Service apply.' A 'Sign Up' button is located below the form. At the bottom of the form, 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'.

VS Code: Install Docker Extension



The screenshot shows the Visual Studio Code interface with the Docker extension installed. The top menu bar includes File, Edit, Selection, View, Go, Run, Terminal, and Help. The title bar reads "Extension: Docker - node_hello_world - Visual Studio Code".

In the left sidebar, the "EXTENSIONS" view is active, showing a search for "docker". The search results list several extensions:

- Docker** (Microsoft): 768ms, "Makes it easy to create, ..." (This extension is highlighted and installed.)
- Docker Ex...** (Jun Han): 519K installs, 4.5 stars, "Manage Docker Contain..." (Install button)
- Docker Co...** (p1c2u): 280K installs, 2 stars, "Manage Docker Compos..." (Install button)
- Docker Linter** (Henrik Sjödh): 185K installs, 2 stars, "Lint perl, python and/or r..." (Install button)
- Docker Ext...** (unidentified): 131K installs, 5 stars

The main panel displays the details for the **Docker** extension (v1.24.0) by Microsoft, which has 21,545,576 installs and a 5-star rating (79 reviews). The description states: "Makes it easy to create, manage, and debug containerized applications." The extension is currently disabled, with "Disable" and "Uninstall" buttons visible. A note indicates "This extension is enabled globally." Below the extension details are tabs for "DETAILS", "FEATURE CONTRIBUTIONS", "CHANGELOG", "DEPENDENCIES", and "RUNTIME STATUS".

At the bottom of the extension details, there is a summary for "Docker for Visual Studio Code" with the following status: version **v1.24.0**, installs **22M**, and a status of **successful** for Azure Pipelines.

The description at the bottom reads: "The Docker extension makes it easy to build, manage, and deploy containerized applications from Visual Studio Code. provides one-click debugging of Node.js, Python, and .NET inside a container."

Verify your installation

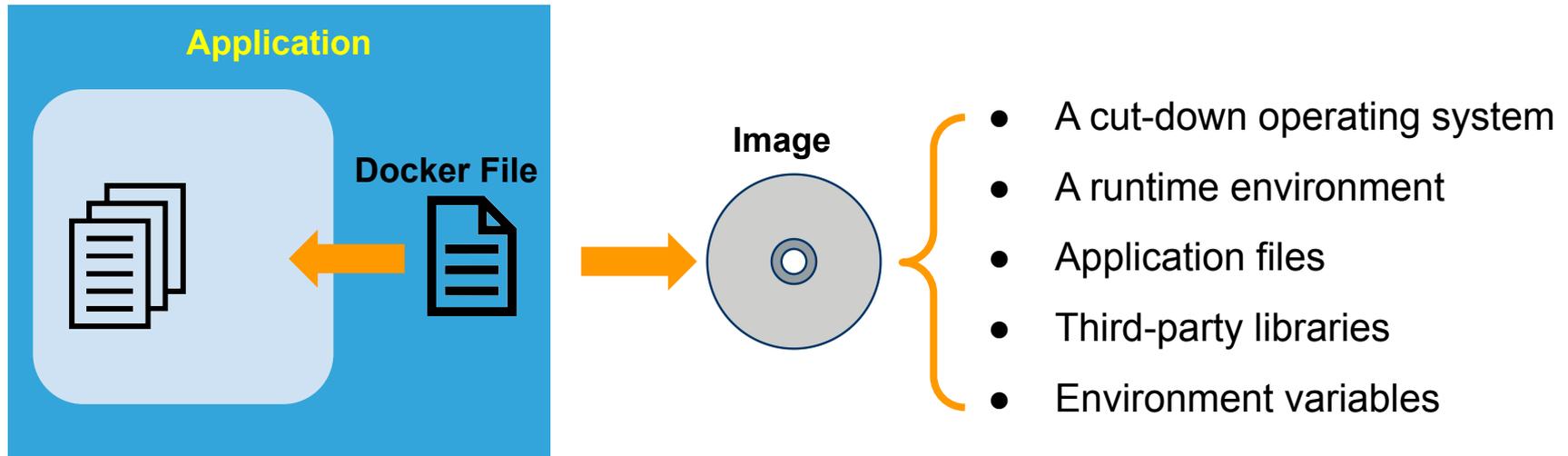
Open a terminal and run:

```
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

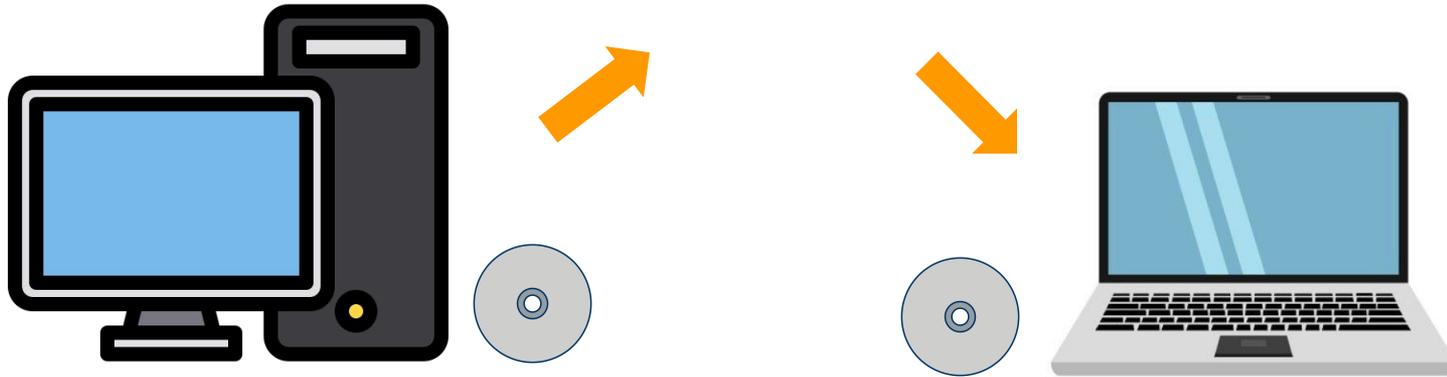
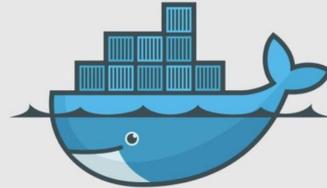
Server: Docker Desktop 4.16.3 (96739)
Engine:
 Version:          20.10.22
 API version:      1.41 (minimum version 1.12)
 Go version:       go1.18.9
 Git commit:       42c8b31
 Built:            Thu Dec 15 22:26:14 2022
 OS/Arch:          linux/amd64
 Experimental:     false
 containerd:
 Version:          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



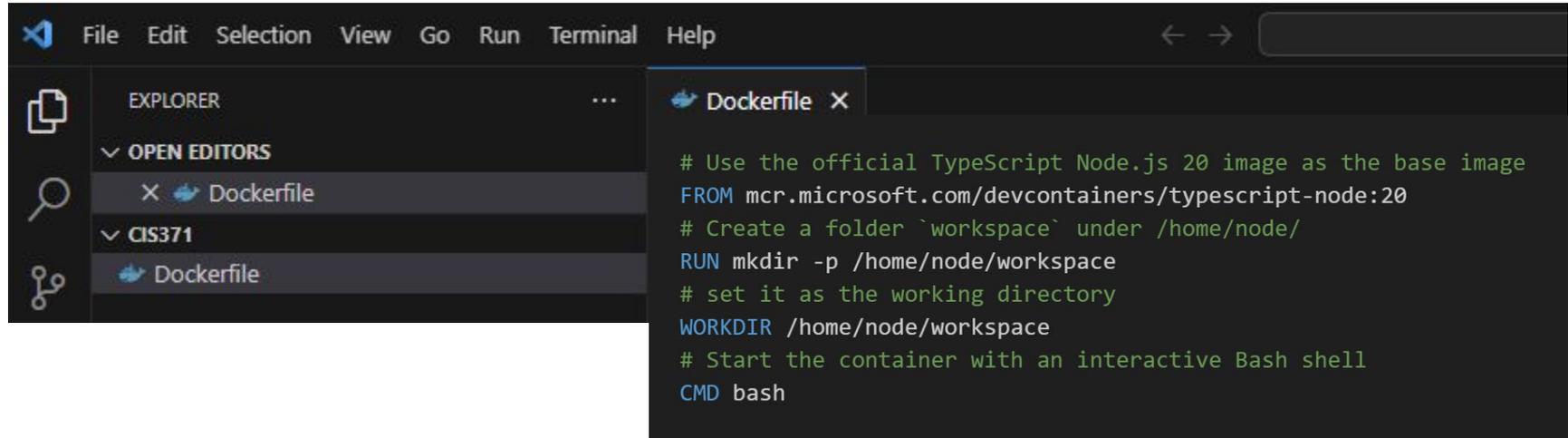
Development Workflow

Docker Hub



Example: Build NodeJS + TypeScript Env. Write Dockerfile

Docker image in Docker hub



```
File Edit Selection View Go Run Terminal Help
EXPLORER
OPEN EDITORS
  Dockerfile
  CIS371
    Dockerfile
Dockerfile X
# Use the official TypeScript Node.js 20 image as the base image
FROM mcr.microsoft.com/devcontainers/typescript-node:20
# Create a folder `workspace` under /home/node/
RUN mkdir -p /home/node/workspace
# set it as the working directory
WORKDIR /home/node/workspace
# Start the container with an interactive Bash shell
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 0.1s
=> [internal] load .dockerignore 0.0s
=> => transferring context: 28 0.0s
=> [internal] load metadata for mcr.microsoft.com/devcontainers/base:ubuntu 1.7s
=> [1/1] FROM mcr.microsoft.com/devcontainers/base:ubuntu@sha256:fdb79b61fb4e955b4042ddb25bbae616316984bcd46c193196c6e1664a5d367f 45.2s
=> => resolve mcr.microsoft.com/devcontainers/base:ubuntu@sha256:fdb79b61fb4e955b4042ddb25bbae616316984bcd46c193196c6e1664a5d367f 0.0s
=> sha256:fdb79b61fb4e955b4042ddb25bbae616316984bcd46c193196c6e1664a5d367f 1.61kB / 1.61kB 0.0s
=> sha256:bc84042d3d31ef92e5449d957cdc0156d76ccl1a8333ba0166240ae5709f4d164 1.81kB / 1.81kB 0.0s
=> sha256:46ddc7dc9a156bef047c96ac331fa66f1e1c47281920a72d11c0b8a9c3c08e66 8.85kB / 8.85kB 0.0s
=> sha256:9d19ee268e0d7bcf6716e6658ee1b0384a71d6f2f9aa1ae2085610cf7c7b316f 30.43MB / 30.43MB 13.5s
=> sha256:97966f3f03442a3d645f8354f49cc622b4416879f6c59142fab244ca2663677b 7.12MB / 7.12MB 2.1s
=> sha256:f8b6dd6574d4a91e537f26304af811f5693269414c91a00fc33576be7fd4f72d 411B / 411B 0.2s
=> sha256:cdb99b969289fd0b2bb0e466becce4169f9d93fb153bf0226c342c7bf0227174 135B / 135B 0.5s
=> sha256:24c81fd0e0d521e7470ea8e587e4153624fdfed939c9f92bf8dd756a56071aca 224B / 224B 0.7s
=> sha256:4c7fc7f7f0efb49ea8c582a361d123c443e16c047ec24efa6bc27858ba3a6d84 234B / 234B 0.9s
=> sha256:2438dbb792cdae919eda60451a9838d269ed25bf3f5b974901f6fcaf01fc2c3 74.61MB / 74.61MB 33.9s
=> sha256:9bd3ec670c1138bc6e45c0849a3a94a517c56d2143c046132076bdb90e1dd75b 149.75MB / 149.75MB 31.4s
=> extracting sha256:9d19ee268e0d7bcf6716e6658ee1b0384a71d6f2f9aa1ae2085610cf7c7b316f 2.1s
=> extracting sha256:97966f3f03442a3d645f8354f49cc622b4416879f6c59142fab244ca2663677b 0.8s
=> extracting sha256:f8b6dd6574d4a91e537f26304af811f5693269414c91a00fc33576be7fd4f72d 0.8s
=> extracting sha256:cdb99b969289fd0b2bb0e466becce4169f9d93fb153bf0226c342c7bf0227174 0.8s
=> extracting sha256:24c81fd0e0d521e7470ea8e587e4153624fdfed939c9f92bf8dd756a56071aca 0.8s
=> extracting sha256:4c7fc7f7f0efb49ea8c582a361d123c443e16c047ec24efa6bc27858ba3a6d84 0.8s
=> extracting sha256:2438dbb792cdae919eda60451a9838d269ed25bf3f5b974901f6fcaf01fc2c3 5.1s
=> extracting sha256:9bd3ec670c1138bc6e45c0849a3a94a517c56d2143c046132076bdb90e1dd75b 5.4s
=> exporting to image 0.8s
=> exporting layers 0.8s
=> writing image sha256:bb947b3cf6187e99c3de07cac62c3087ba55d6570d82e874a770c817f77f6485 0.8s
=> naming to docker.io/jazz14jazz/cis371 0.8s
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 [Give feedback](#)

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

Name	Tag	Status	Created	Size	Actions
jazz14jazz/cis371 1b971acc297e	latest	In use	about 1 month ago	1.67 GB	

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 → / $
```

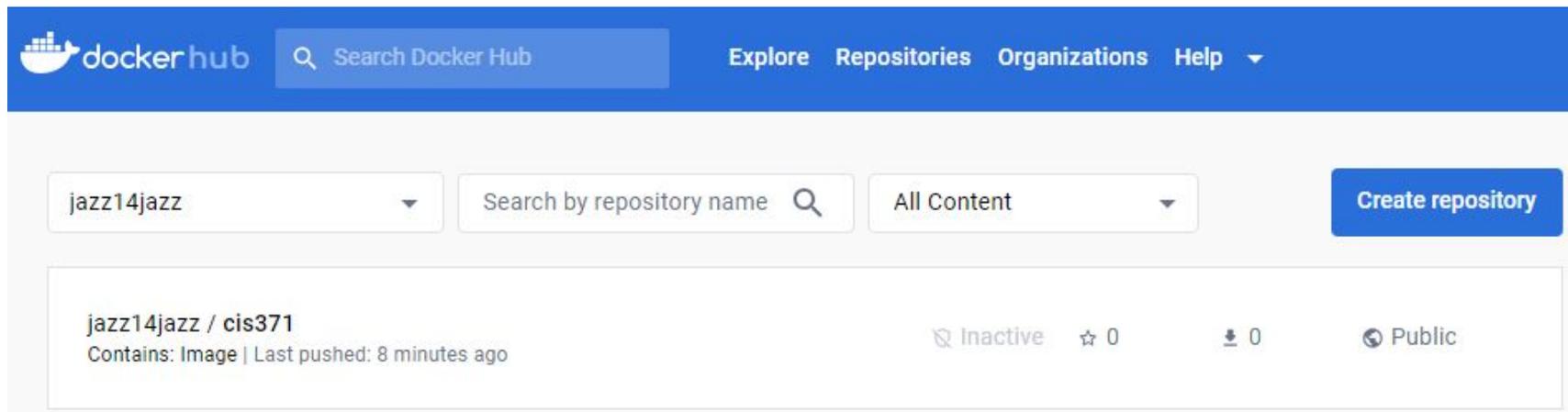
```
/* Verify following installations in your container */  
root → / $ node -v  
v20.5.0  
root → / $ npm -v  
9.8.1  
root → / $ npx -v  
9.8.1  
root → / $ tsc -v  
Version 5.1.6
```

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 displays the Docker Hub search interface. At the top, there is a blue navigation bar with the Docker Hub logo, a search bar containing 'Search Docker Hub', and links for 'Explore', 'Repositories', 'Organizations', and 'Help'. Below the navigation bar, there is a search results area. On the left, a dropdown menu shows 'jazz14jazz'. In the center, there is a search bar with the text 'Search by repository name' and a magnifying glass icon. To the right of the search bar, there is another dropdown menu showing 'All Content'. Further right is a blue button labeled 'Create repository'. Below these elements, a search result is displayed for 'jazz14jazz / cis371'. The result shows 'Contains: Image | Last pushed: 8 minutes ago'. To the right of the repository name, there are icons for 'Inactive' (a crossed-out square), '0' stars, '0' downloads, and 'Public' (a globe icon).

More Docker Commands

[All Commands](#)

[Cheat Sheet](#)

VS Code: Install Remote Development Extension

The screenshot displays the Visual Studio Code interface with the Extensions Marketplace open. The search bar contains "Dev Containers extension". The "Remote Development" extension by Microsoft is selected and shown in detail. The extension's description is "An extension pack that lets you open any folder in a container, on a...". It has a version of v0.24.0 and is marked as a "Preview". The extension pack includes "Remote - SSH" and "WSL".

EXTENSIONS: MARKET... Extension: Remote Development

Remote Deve... 4.4M ★ 4.5
An extension pack that lets ...
Microsoft [Install](#)

EV Business Cen... 1K ★ 5
Tool to Manage: Containers, ...
ElbekVejrup [Install](#)

OpenShift Extensi... 15K
Collection of extensions cur...
Red Hat [Install](#)

gbe0 Docker Extens... 87
Docker extension package f...
gbe0 [Install](#)

gbe0 Perl Extension... 41
Perl extension package for d...
gbe0 [Install](#)

gbe0 Puppet Extens... 26

Remote Development v0.24.0 Preview
Microsoft microsoft.com | 4,456,050 | ★★★★★ (107)
An extension pack that lets you open any folder in a container, on a...
[Install](#)

DETAILS

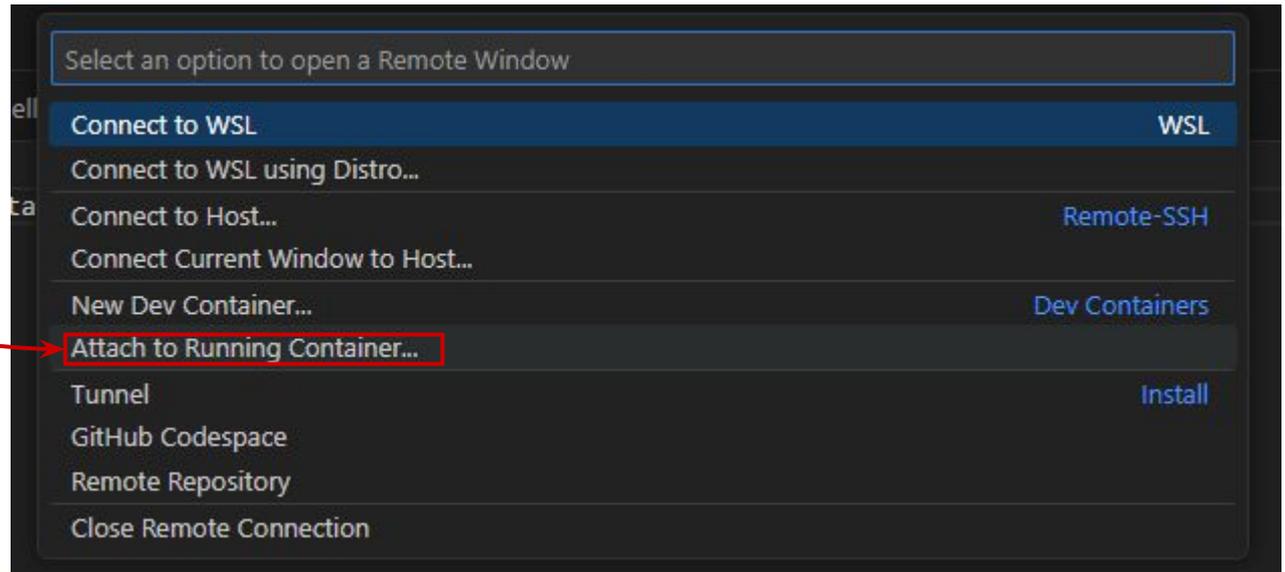
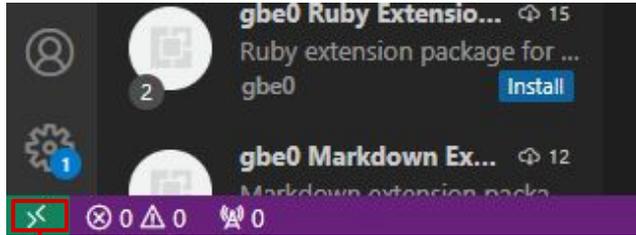
Extension Pack (4)

- Remote - SSH**
Open any folder on a remote machine using ...
Microsoft
- WSL**
Open any folder in the Windows Subsystem ...
Microsoft [Install](#)

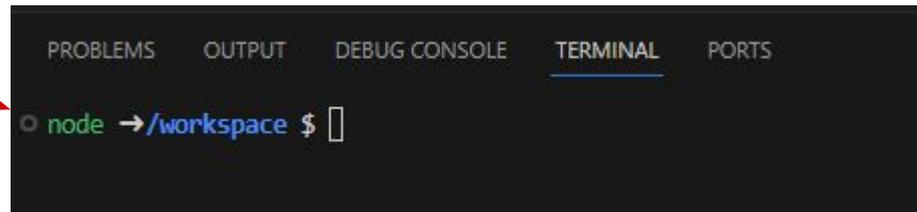
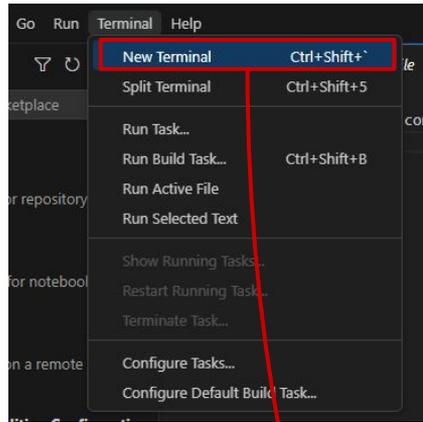
Categories
[Extension Packs](#)

Extension Resources
[Marketplace](#)
[Repository](#)
[License](#)

VS Code: Open the container in VS Code



VS Code: Open a terminal in VS Code



Code Formatting: Prettier

<https://www.youtube.com/watch?v=DqfQ4DPnRqI>



A screenshot of the Visual Studio Code interface. The left sidebar shows the "EXTENSIONS" view with a search bar and a list of installed and recommended extensions. The "Prettier - Code formatter" extension is highlighted. The main area displays the extension's details page, including its name, version (v11.0.0), author (prettier.io), download count (48,764,398), and star rating (4.6/5). It also shows the extension is enabled on the current container. Below the details, there are tabs for "DETAILS", "FEATURES", and "CHANGELOG". The "DETAILS" tab is active, showing a description of Prettier as an opinionated code formatter and a list of supported languages: JavaScript, TypeScript, Flow, JSX, JSON, CSS, SCSS, Less, HTML, Vue, Angular, HANDLEBARS, Ember, Glimmer, GraphQL, Markdown, and YAML. At the bottom, there are statistics for the extension: Main (passing), downloads (238M), installs (49M), code style (prettier), and follow prettier.