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.

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

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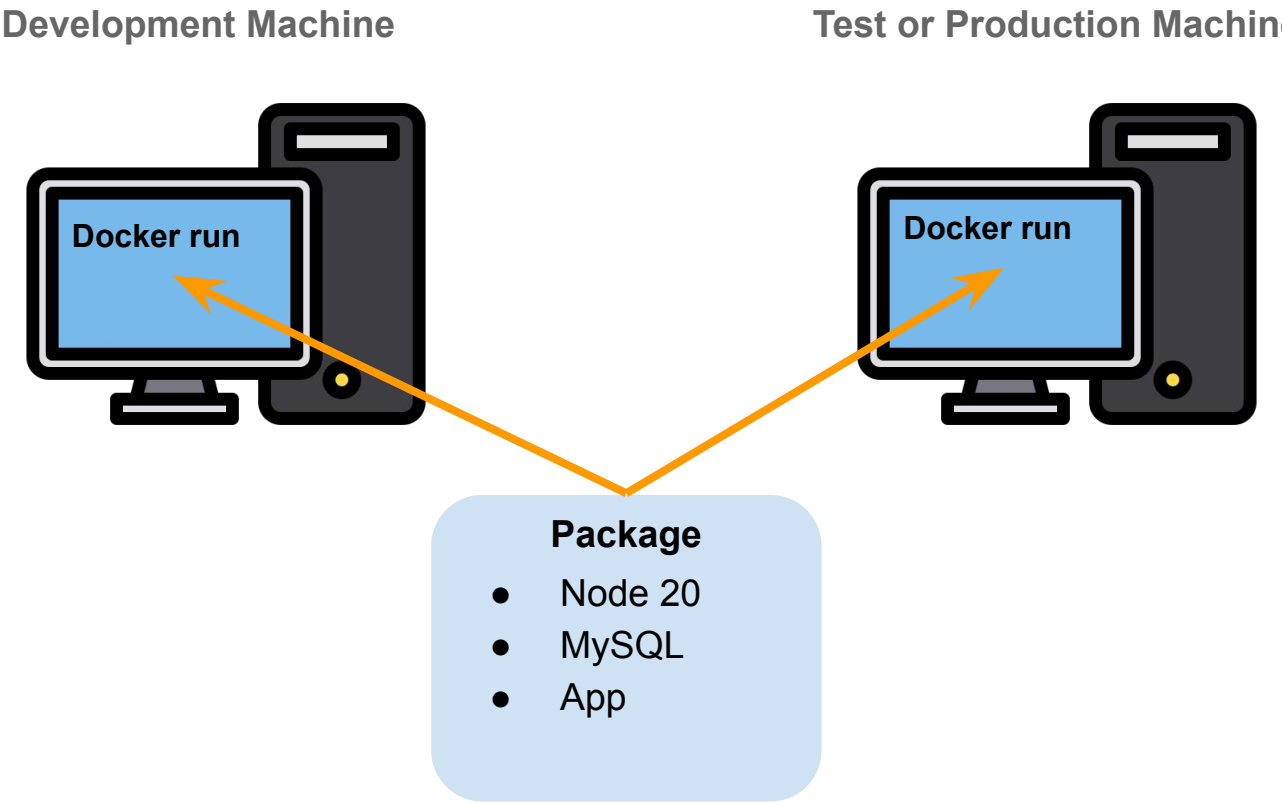
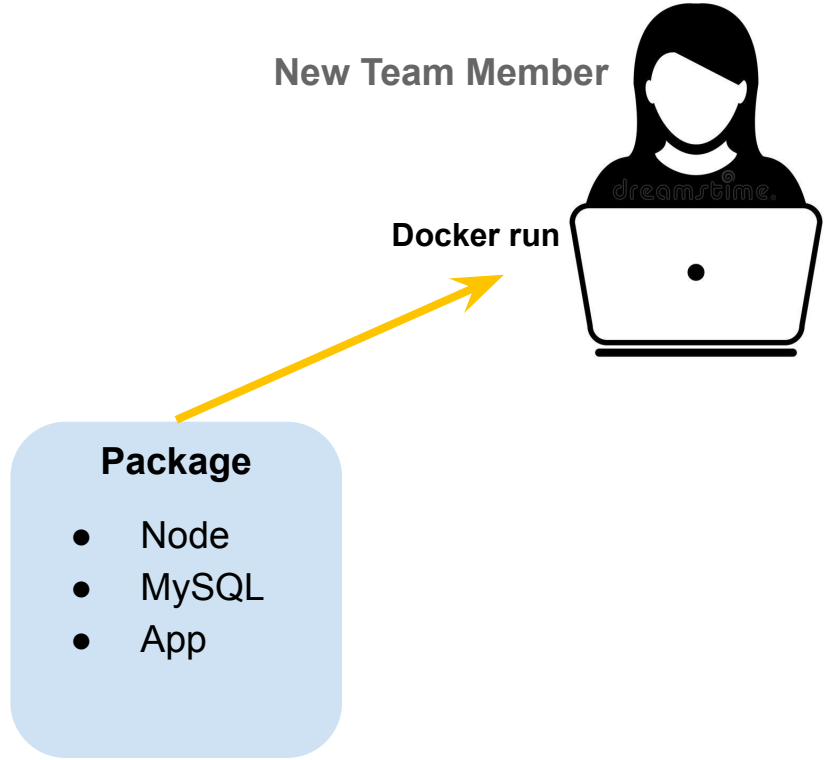
- **Software version mismatch**
- **Different configuration settings**

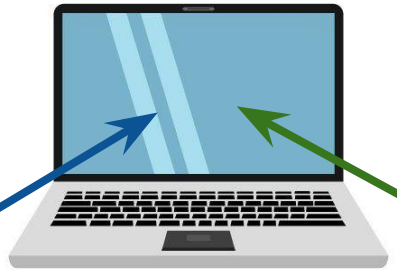
Advantage: Portability & Faster Deployments



Advantage: Sharing & Simplified Dependency



Advantage: Isolation & Security Sandbox



Package 2

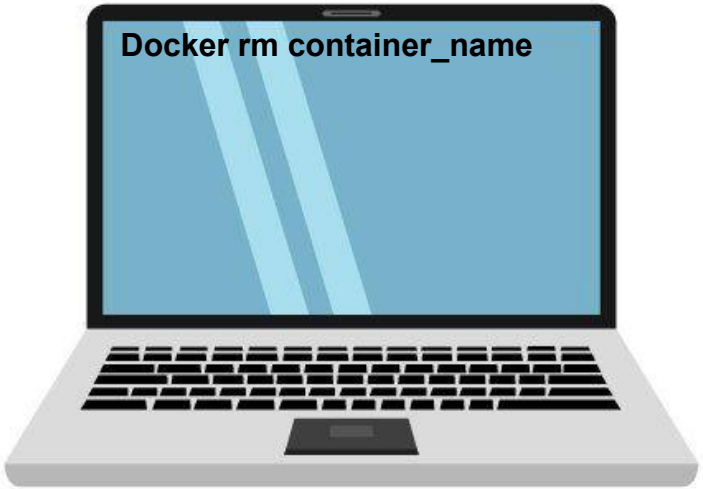
- Node 14
- App 1

Package 3

- Node 20
- App 2

One more benefit

What is Docker?



What is Docker?

A platform for

Consistently

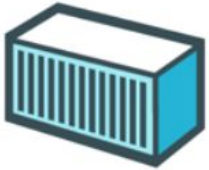
building, running, and shipping applications.

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.



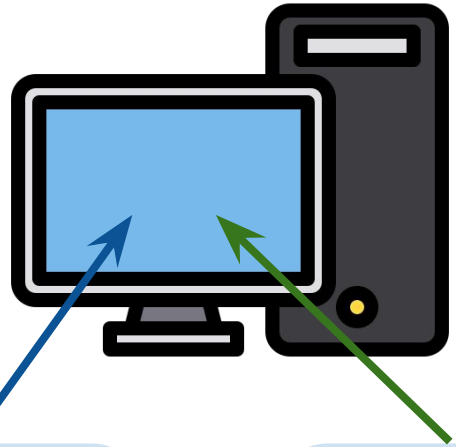
Ship

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 Machine 1

- Node 14
- App 1

Virtual Machine 2

- Node 10
- App 2

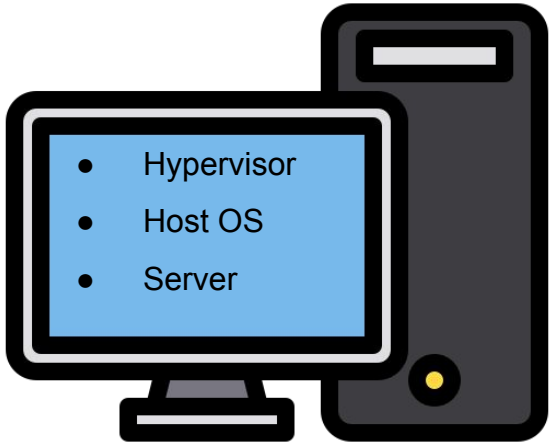
Virtual Machines

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**

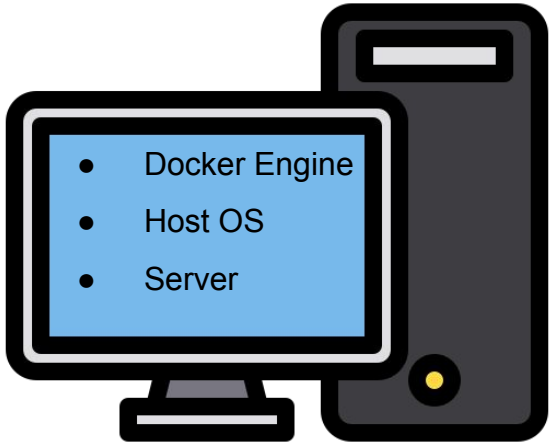
Docker Containers

Container 1

- App 1
- Bins/Libs

Container 2

- App 2
- Bins/Libs

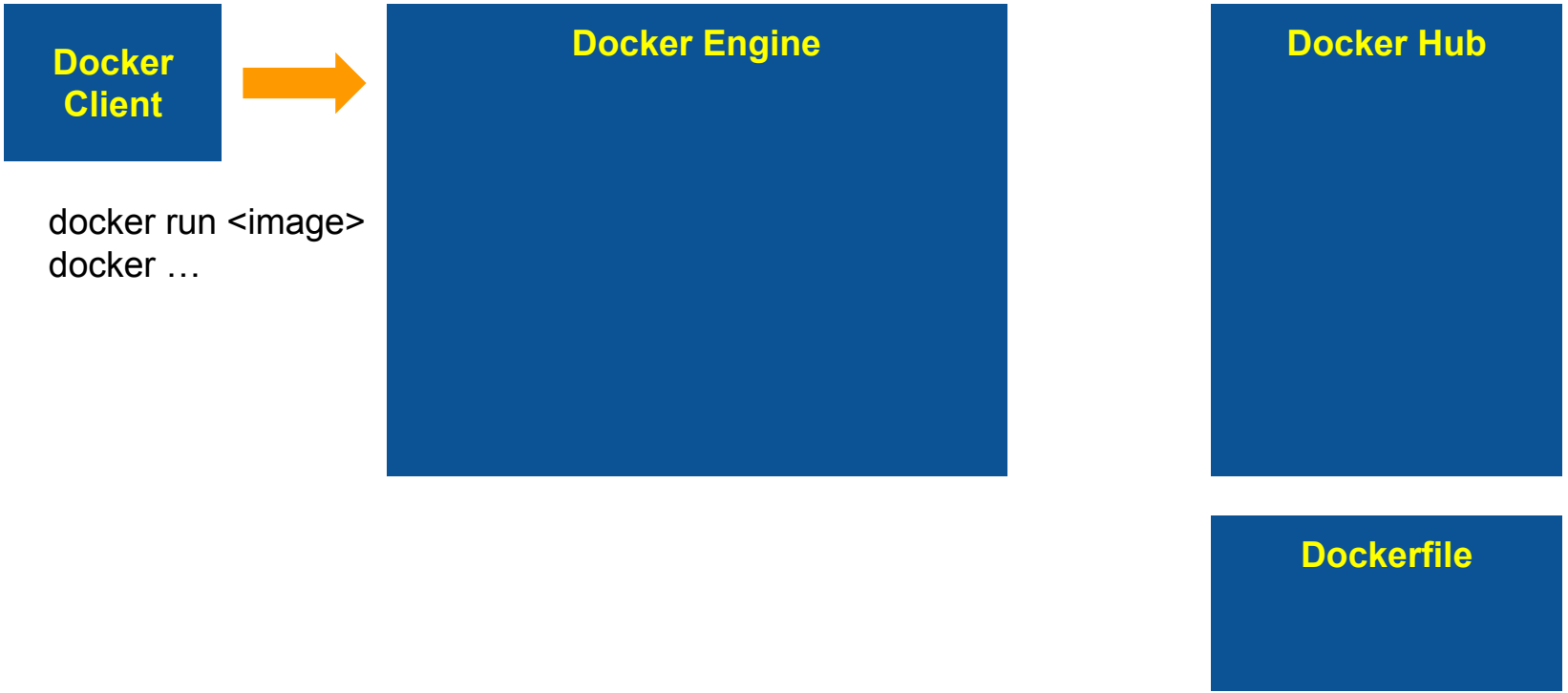


Docker Container

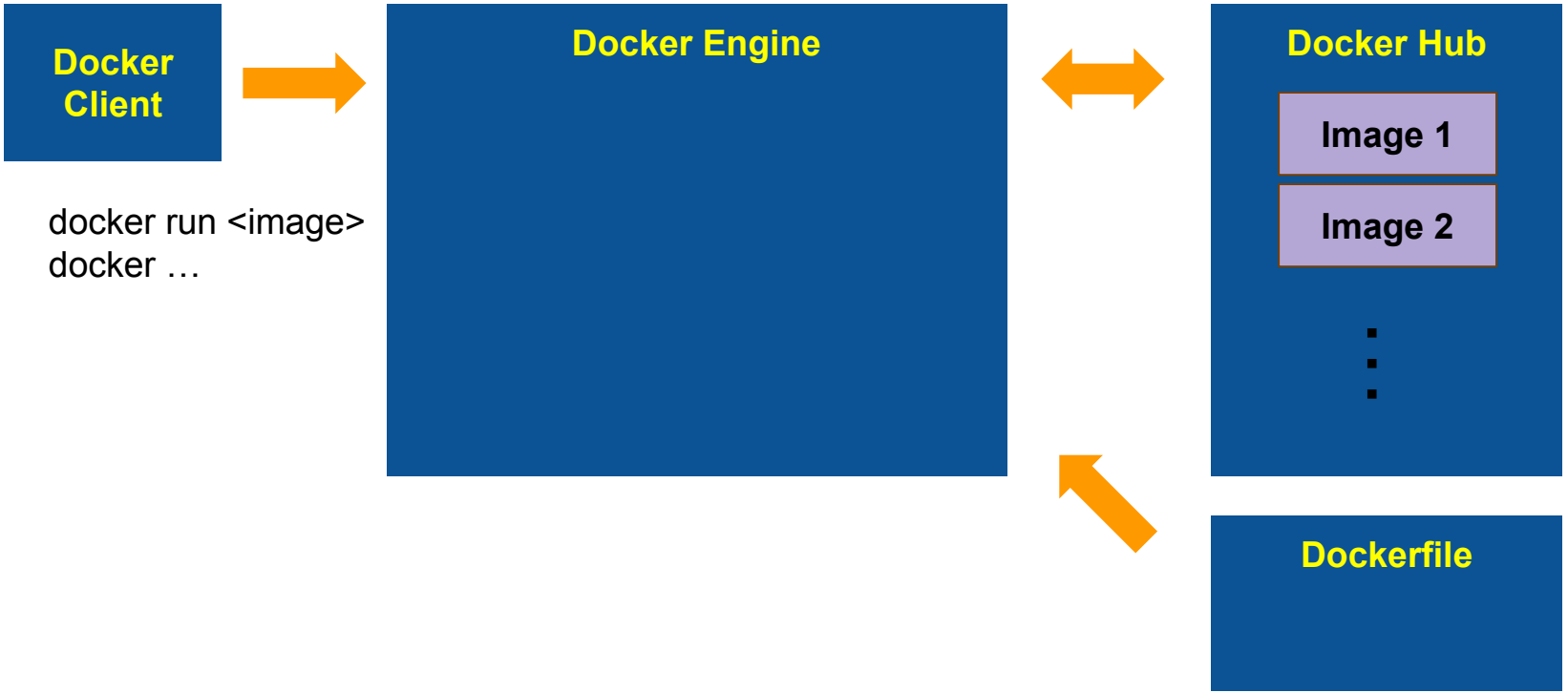
An isolated environment for running an application

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

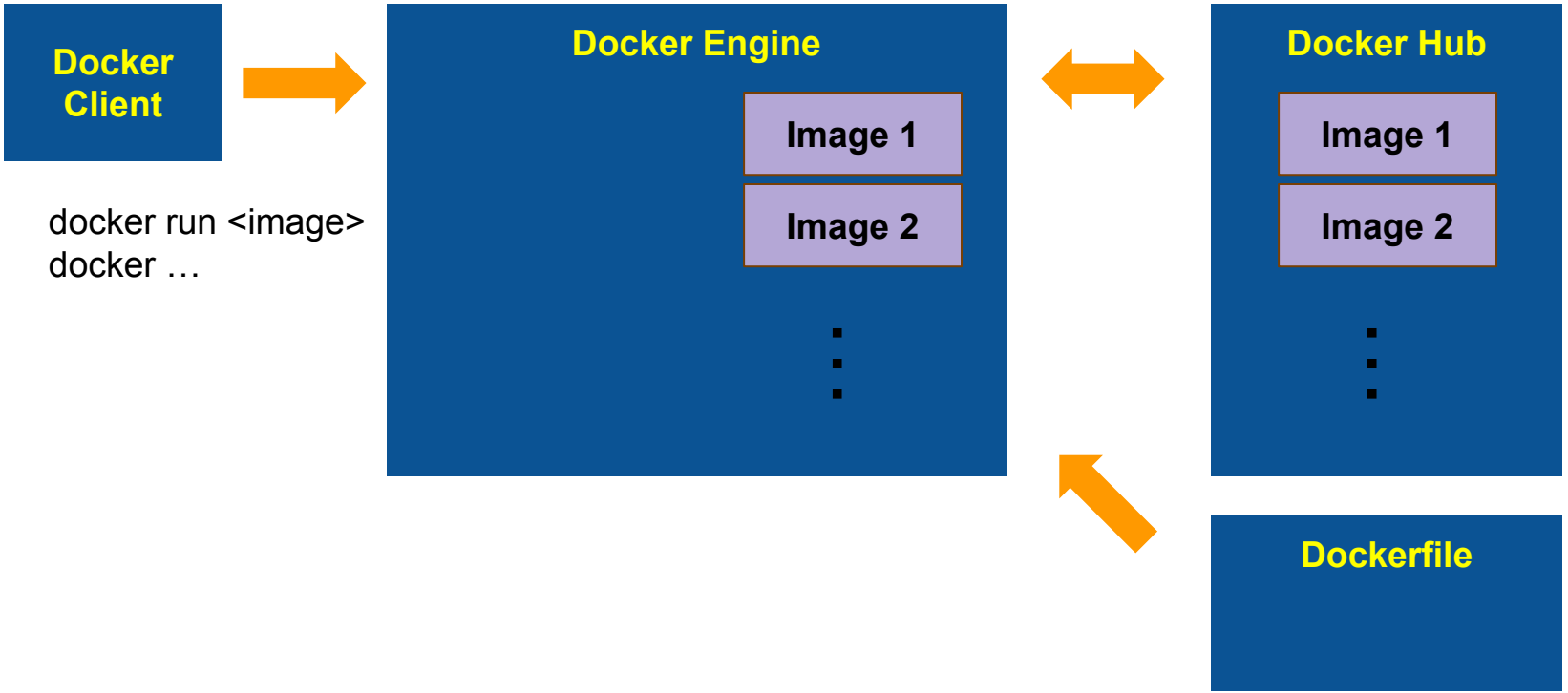
Docker Architecture and Workflow



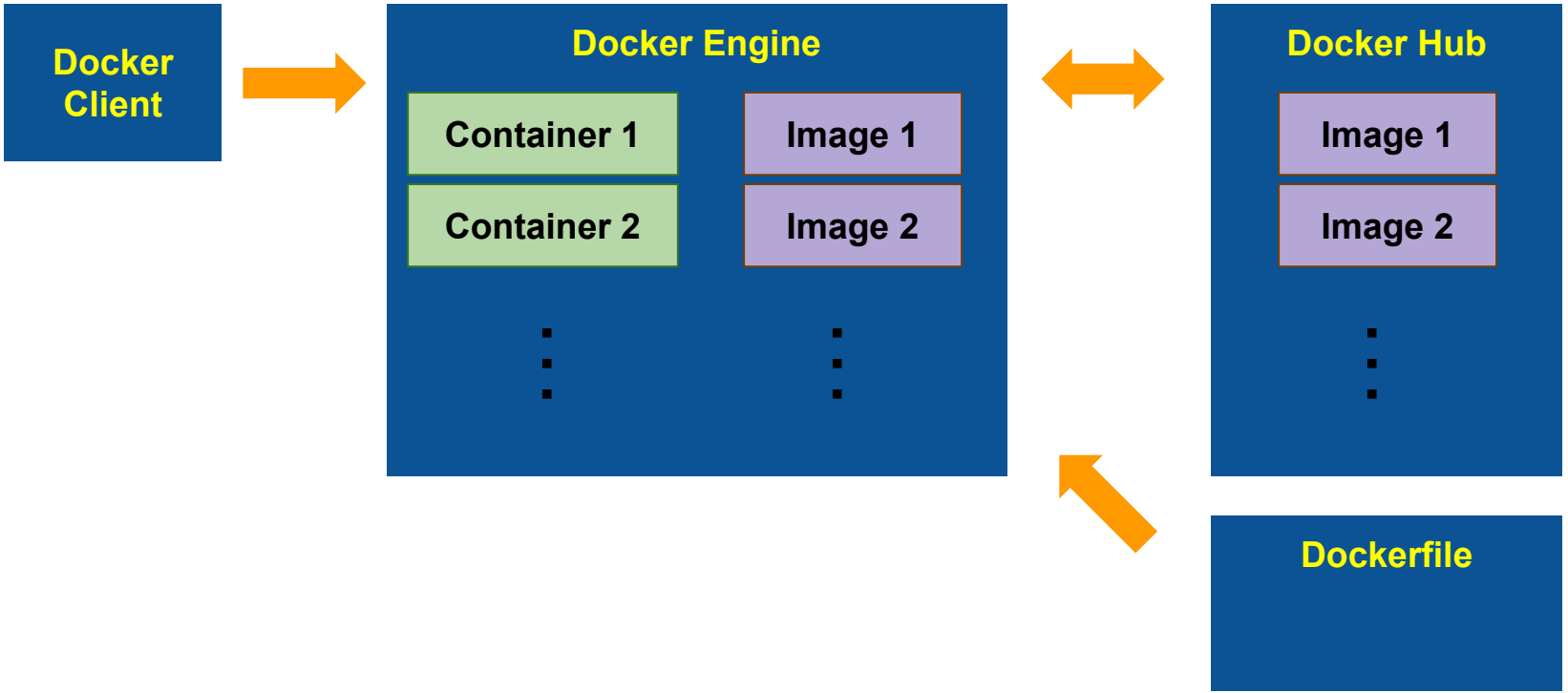
Docker Architecture and Workflow



Docker Architecture and Workflow

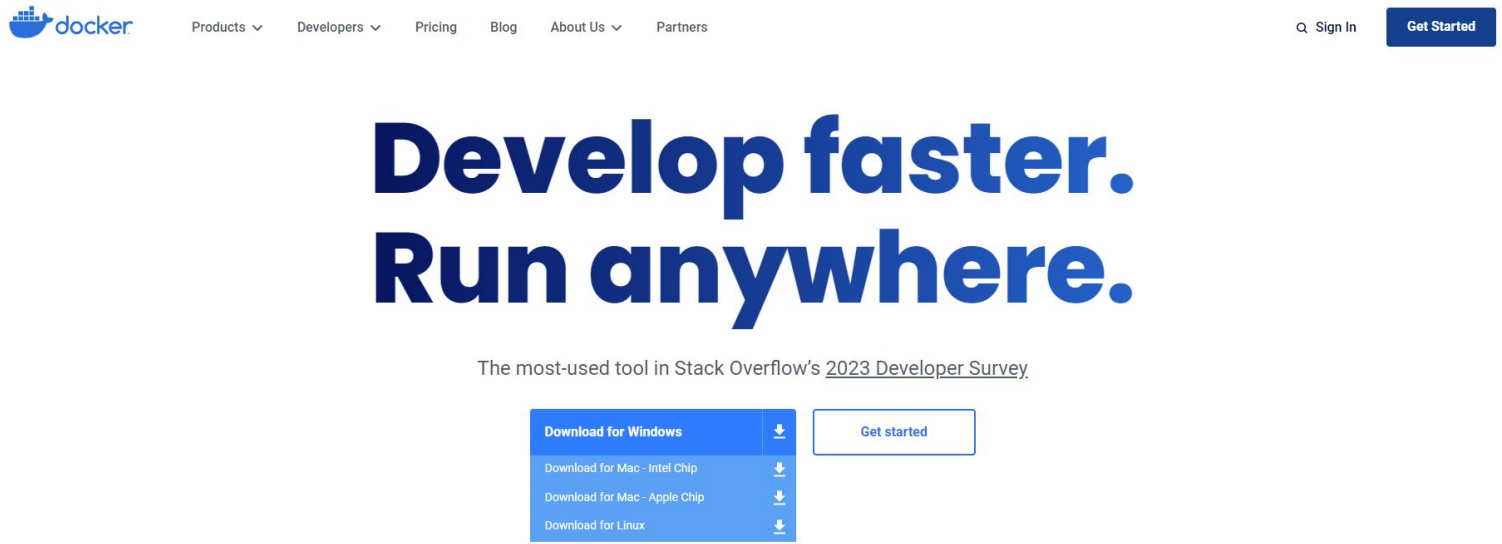


Docker Architecture and Workflow



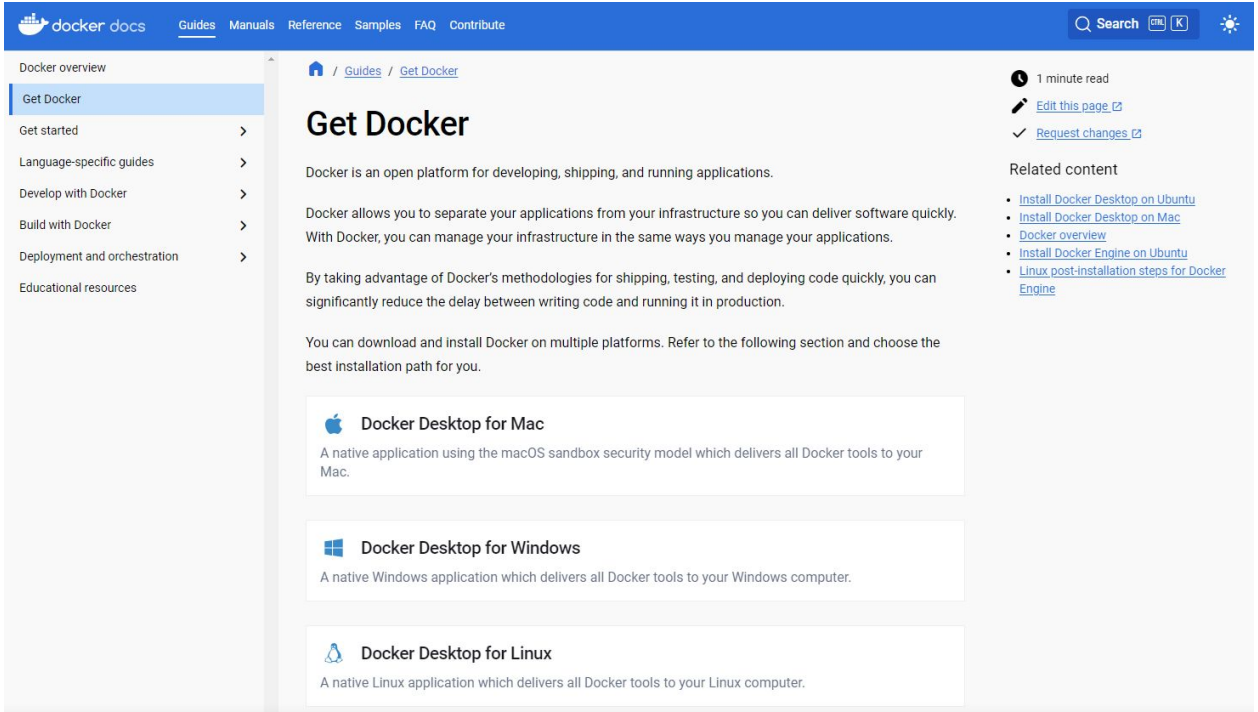
Installing Docker

docker.com



Installing Docker

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

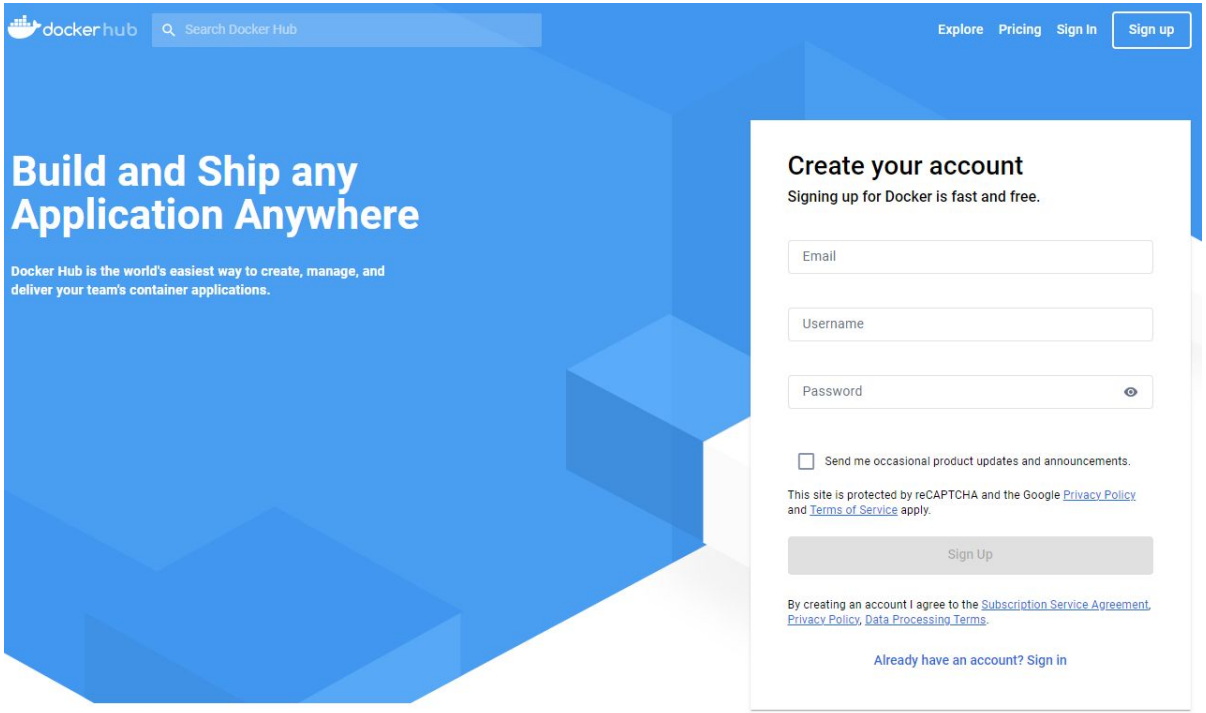


Setup Videos

- windows
- macOS

Docker Hub

https://hub.docker.com/



VS Code: Install Docker Extension

Verify your installation

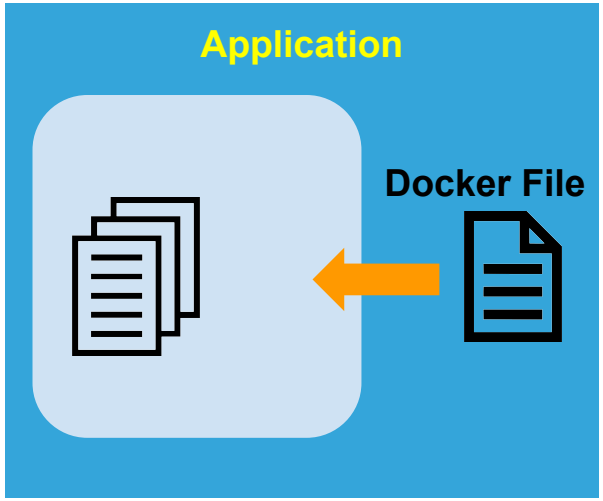
Open a terminal and run:

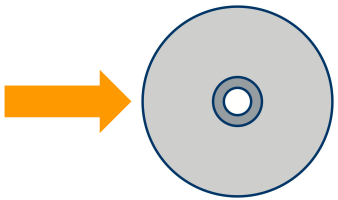
```
docker version
```

```
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
```

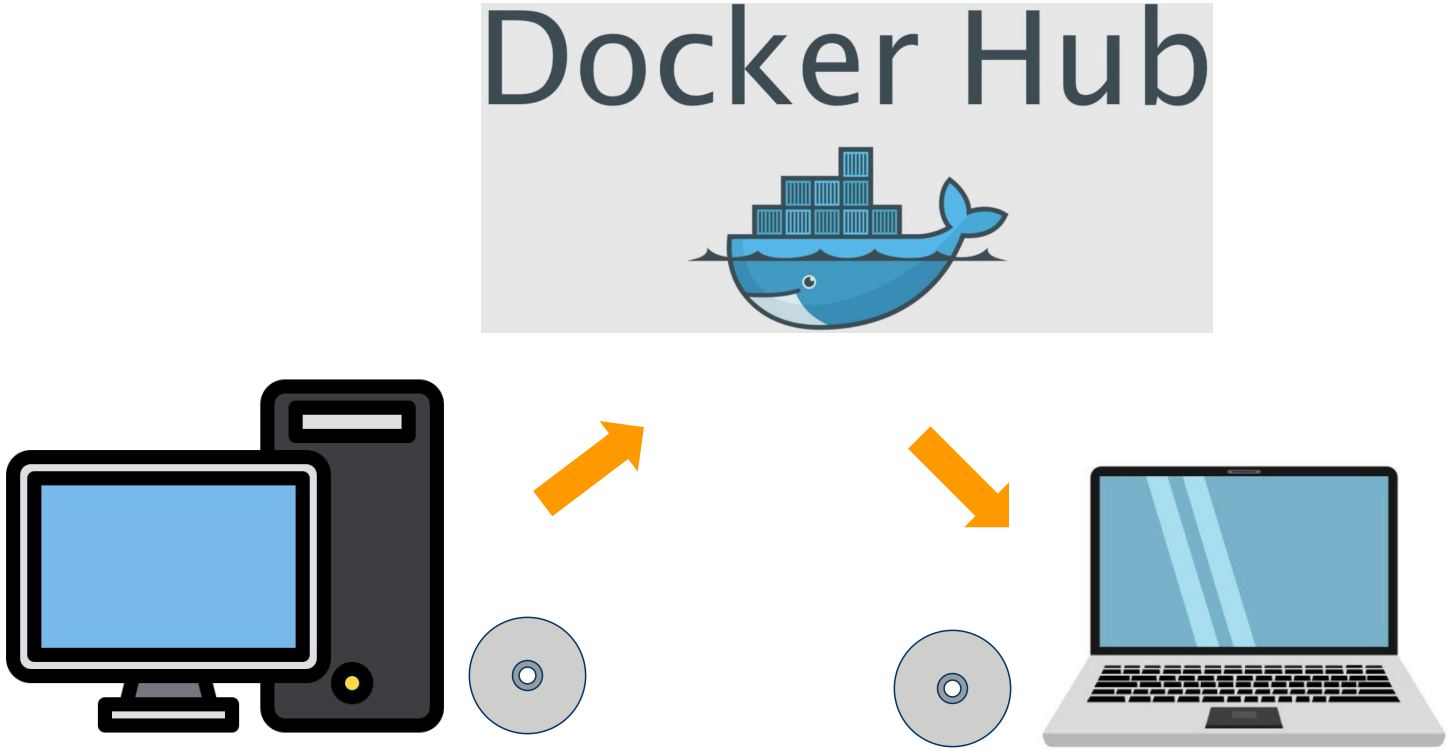
Development Workflow





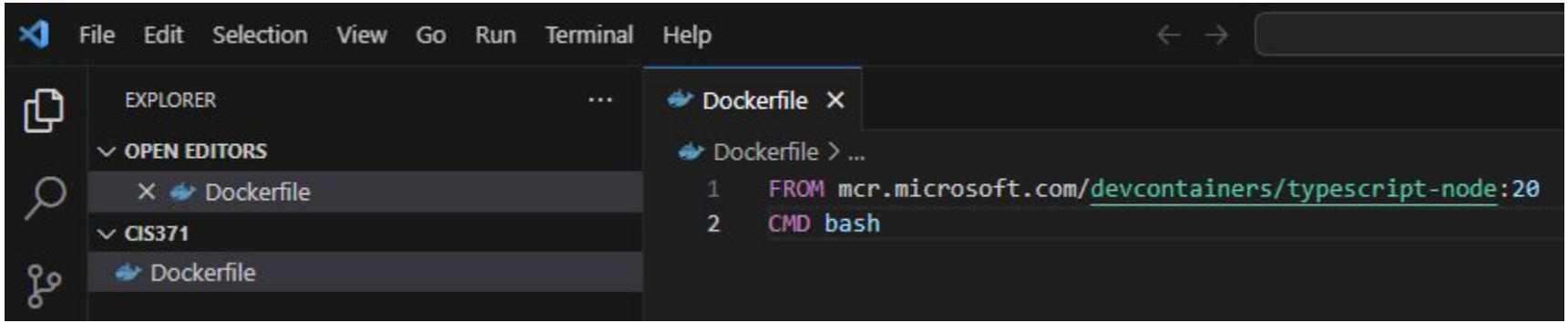
- A cut-down operating system
- A runtime environment
- Application files
- Third-party libraries
- Environment variables

Development Workflow



Example: Build NodeJS + TypeScript Env. Write Dockerfile

Docker image in Docker hub



Microsoft Devcontainers

Best practices for writing Dockerfiles

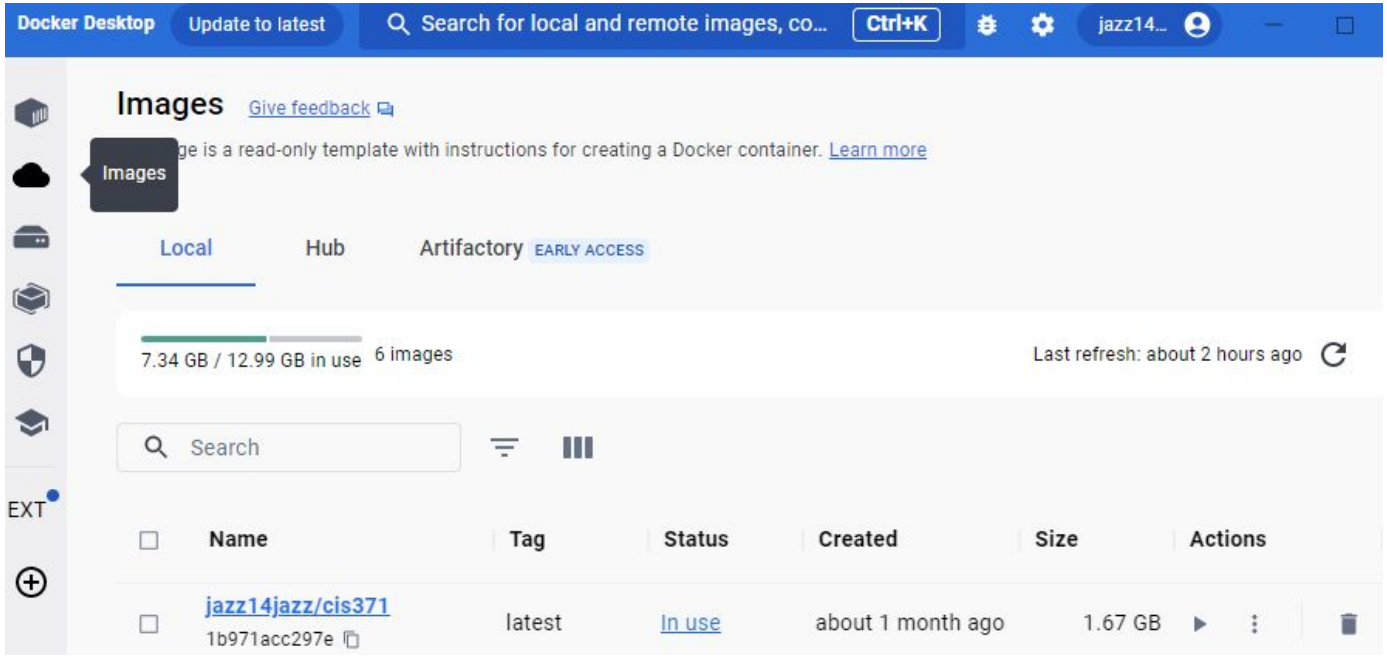
Build Image

```
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                                                                                                0.1s
 => => transferring dockerfile: 95B                                                                                                                 0.0s
 => [internal] load .dockerignore                                                                                                                   0.0s
 => => transferring context: 2B                                                                                                                     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:bc84042d3d31ef92e5449d957cdc0156d76cc1a8333ba0166240ae5709f4d164 1.81kB / 1.81kB                                                      0.0s
 => => sha256:46ddc7dc0a156bef047c96ac331fa66f1e1c47281920a72d11c0b8a9c3c08e66 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:cdb99b969289fd0b2bb0e466becee4169f9d93fb153bf0226c342c7bf0227174 135B / 135B                                                          0.5s
 => => sha256:24c81fd0e0d521e7470ea8e587e4153624fdfed939c9f92bf8dd756a56071aca 224B / 224B                                                          0.7s
 => => sha256:4c7fc7f7f0efb49ea8c582a361d123c443e16c047ec24efa6bc27858ba3a6d84 234B / 234B                                                          0.9s
 => => sha256:2438dbb792cdaea919eda60451a9838d269ed25bf3f5b974901f6fcaf01fc2c3 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                                                           0.0s
 => => extracting sha256:cdb99b969289fd0b2bb0e466becee4169f9d93fb153bf0226c342c7bf0227174                                                           0.0s
 => => extracting sha256:24c81fd0e0d521e7470ea8e587e4153624fdfed939c9f92bf8dd756a56071aca                                                           0.0s
 => => extracting sha256:4c7fc7f7f0efb49ea8c582a361d123c443e16c047ec24efa6bc27858ba3a6d84                                                           0.0s
 => => extracting sha256:2438dbb792cdaea919eda60451a9838d269ed25bf3f5b974901f6fcaf01fc2c3                                                           5.1s
 => => extracting sha256:9bd3ec670c1138bc6e45c0849a3a94a517c56d2143c046132076bdb90e1dd75b                                                           5.4s
 => exporting to image                                                                                                                              0.0s
 => => exporting layers                                                                                                                             0.0s
 => => writing image sha256:bb947b3cf6187e99c3de07cac62c3087ba55d6570d82e874a770c817f77f6485                                                        0.0s
 => => naming to docker.io/jazz14jazz/cis371                                                                                                        0.0s
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
```



Create a Container(Do This Once)

```
/* Create a container using docker run */
docker run --name conatainer_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 ➜ / $
```

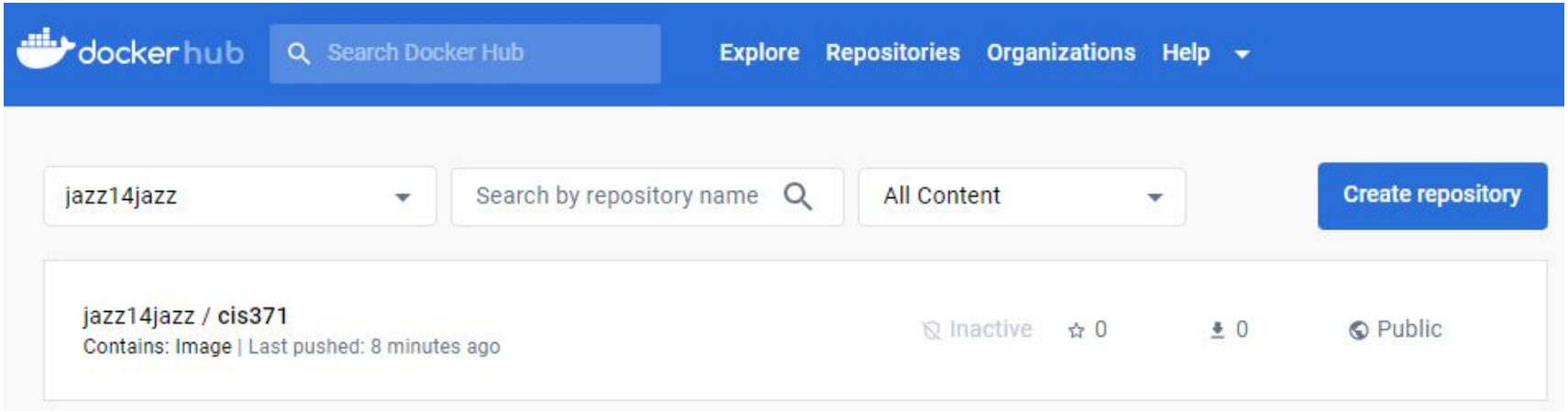
```
/* Verify following installations in your container */
root ➜ / $ node -v
v20.5.0
root ➜ / $ npm -v
9.8.1
root ➜ / $ npx -v
9.8.1
root ➜ / $ tsc -v
Version 5.1.6
```

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
```

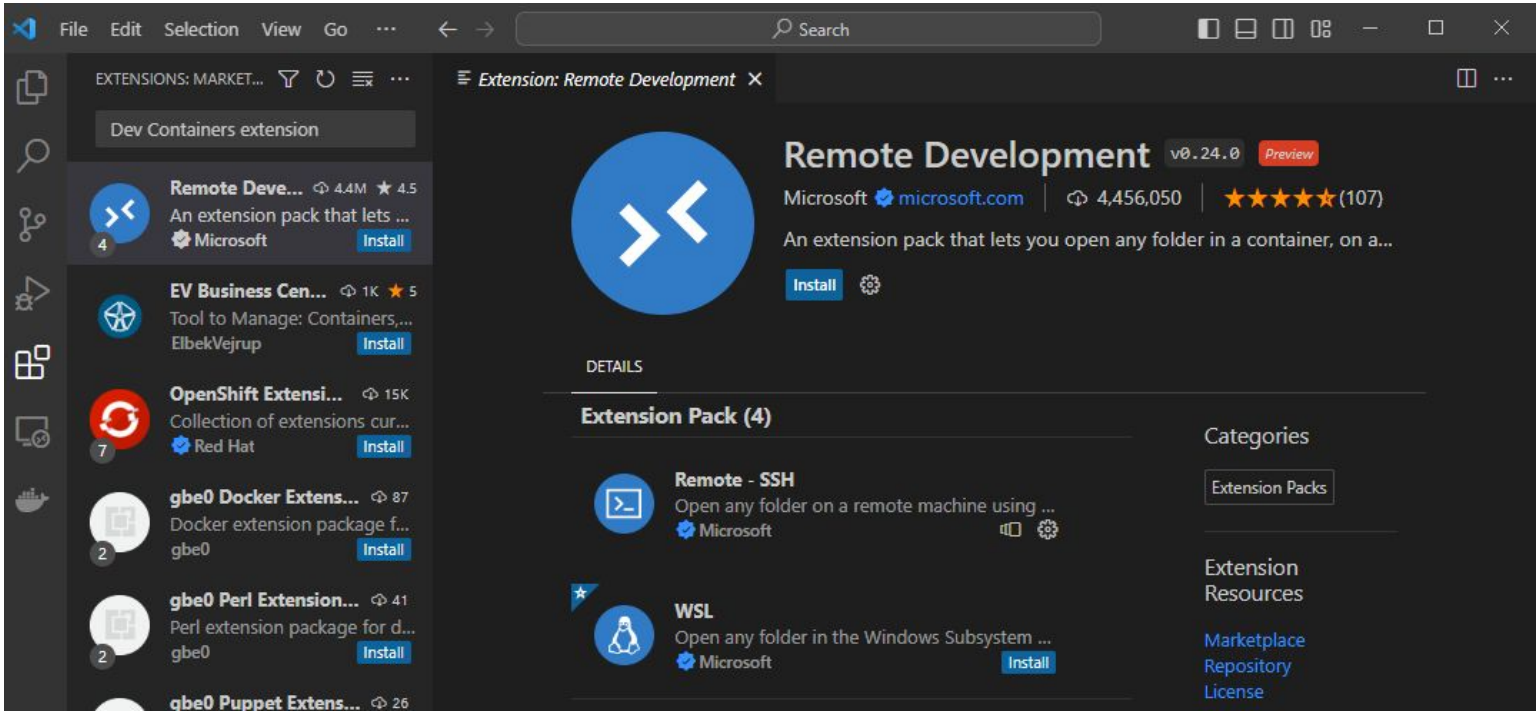


More Docker Commands

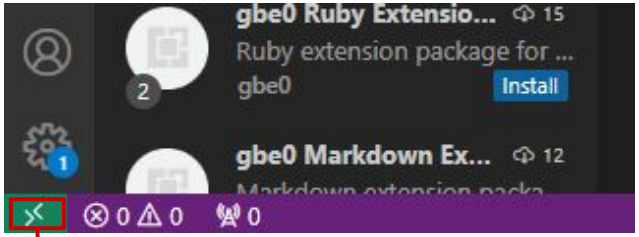
All Commands

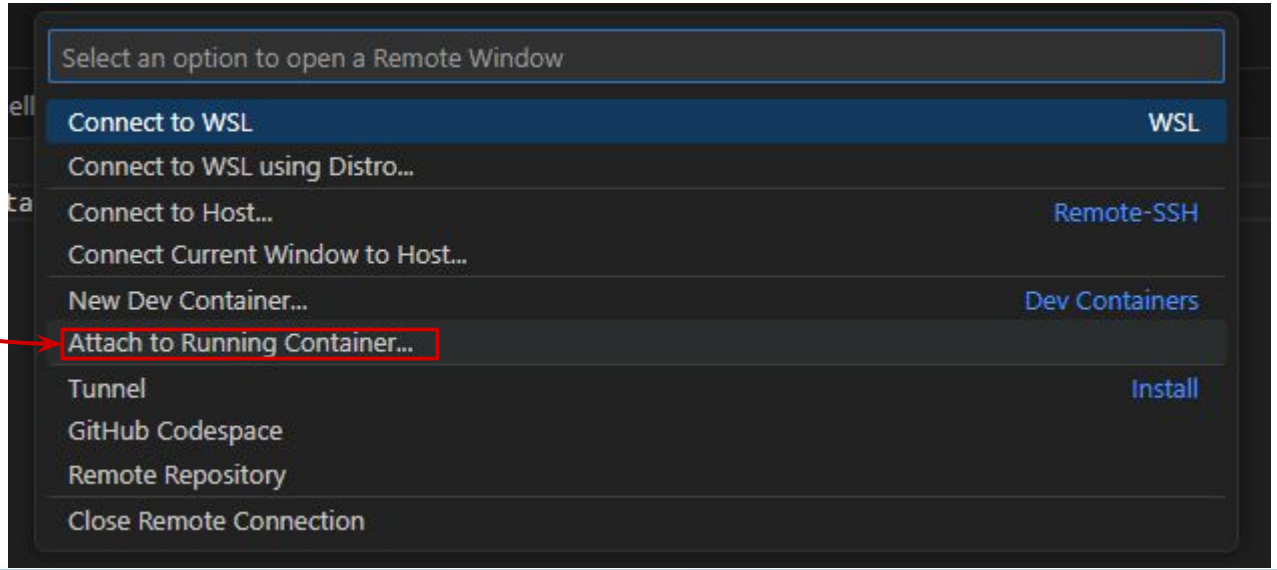
Cheat Sheet

VS Code: Install Remote Development Extension



VS Code: Open the container in VS Code





VS Code: Open a terminal in VS Code