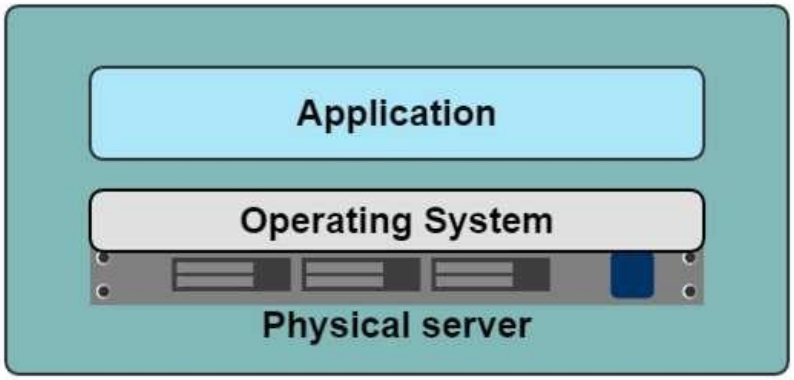
Docker

A History Lesson

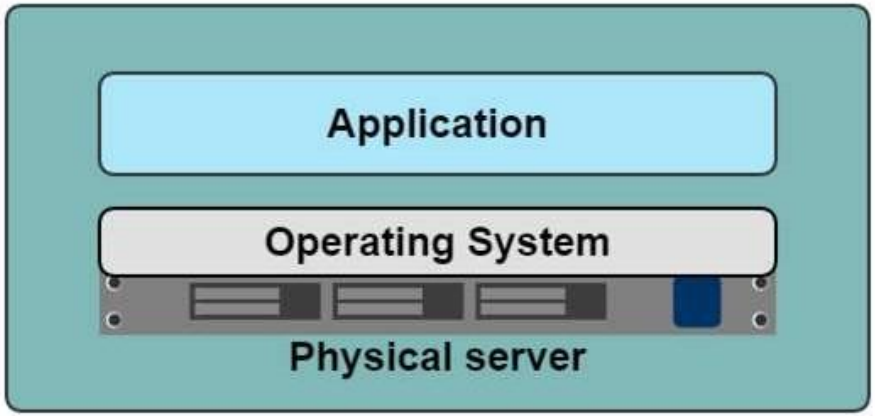
In the Dark Ages

One application on one physical server



Historical limitations of application deployment

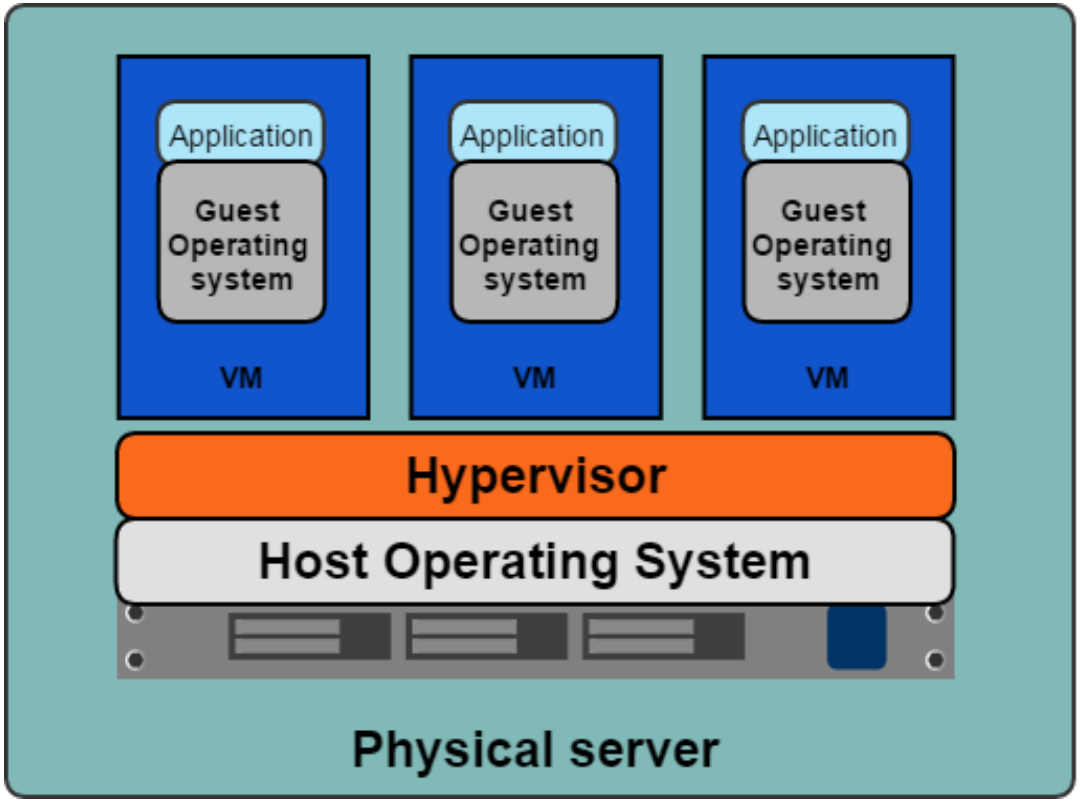
- Slow deployment times
- Huge costs
- Wasted resources
- Difficult to scale
- Difficult to migrate
- Vendor lock in



A History Lesson

Hypervisor-based Virtualization

- One physical server can contain multiple applications
- Each application runs in a virtual machine (VM)



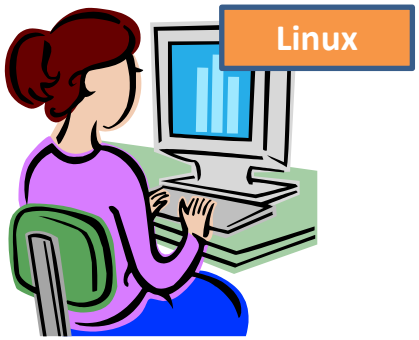
Benefits of VMs

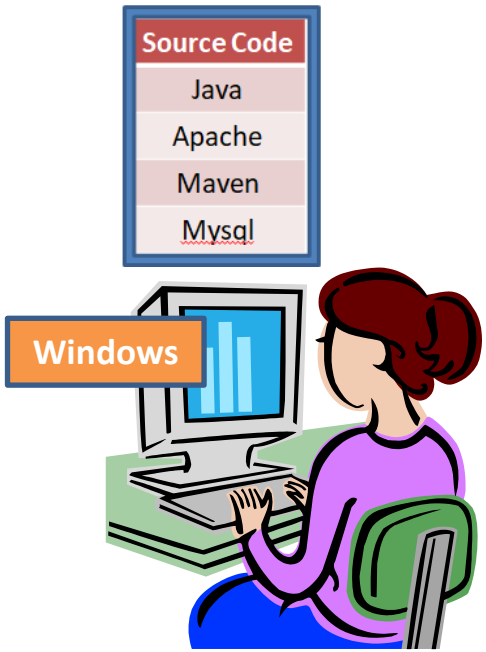
- Better resource pooling
  - One physical machine divided into multiple virtual machines
- Easier to scale
- VMs in the cloud
  - Rapid elasticity
  - Pay as you go model

Limitations of VMs

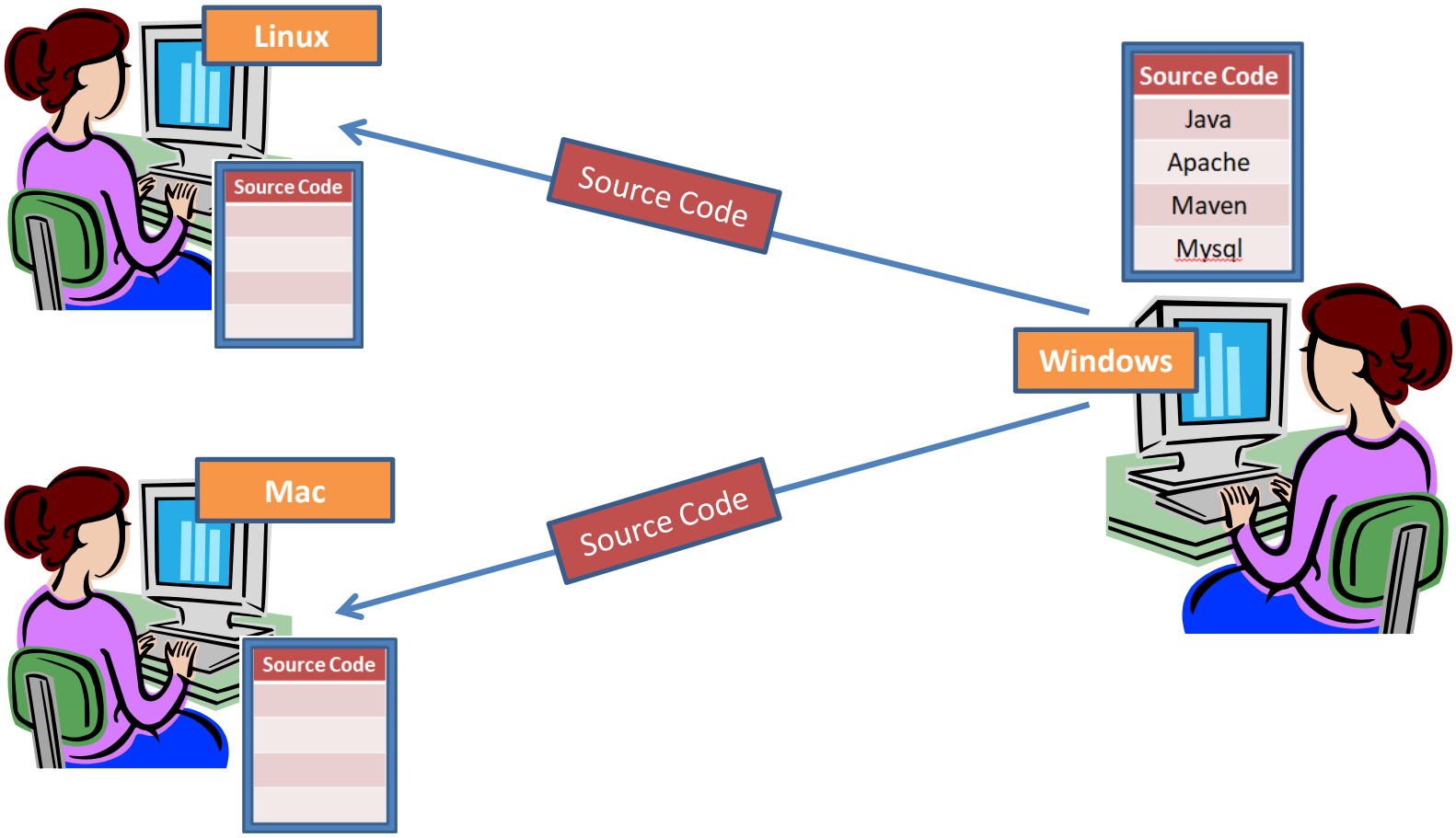
- Each VM stills requires
  - CPU allocation
  - Storage
  - RAM
  - An entire guest operating system
- The more VMs you run, the more resources you need
- Guest OS means wasted resources
- Application portability not guaranteed

Why Docker?

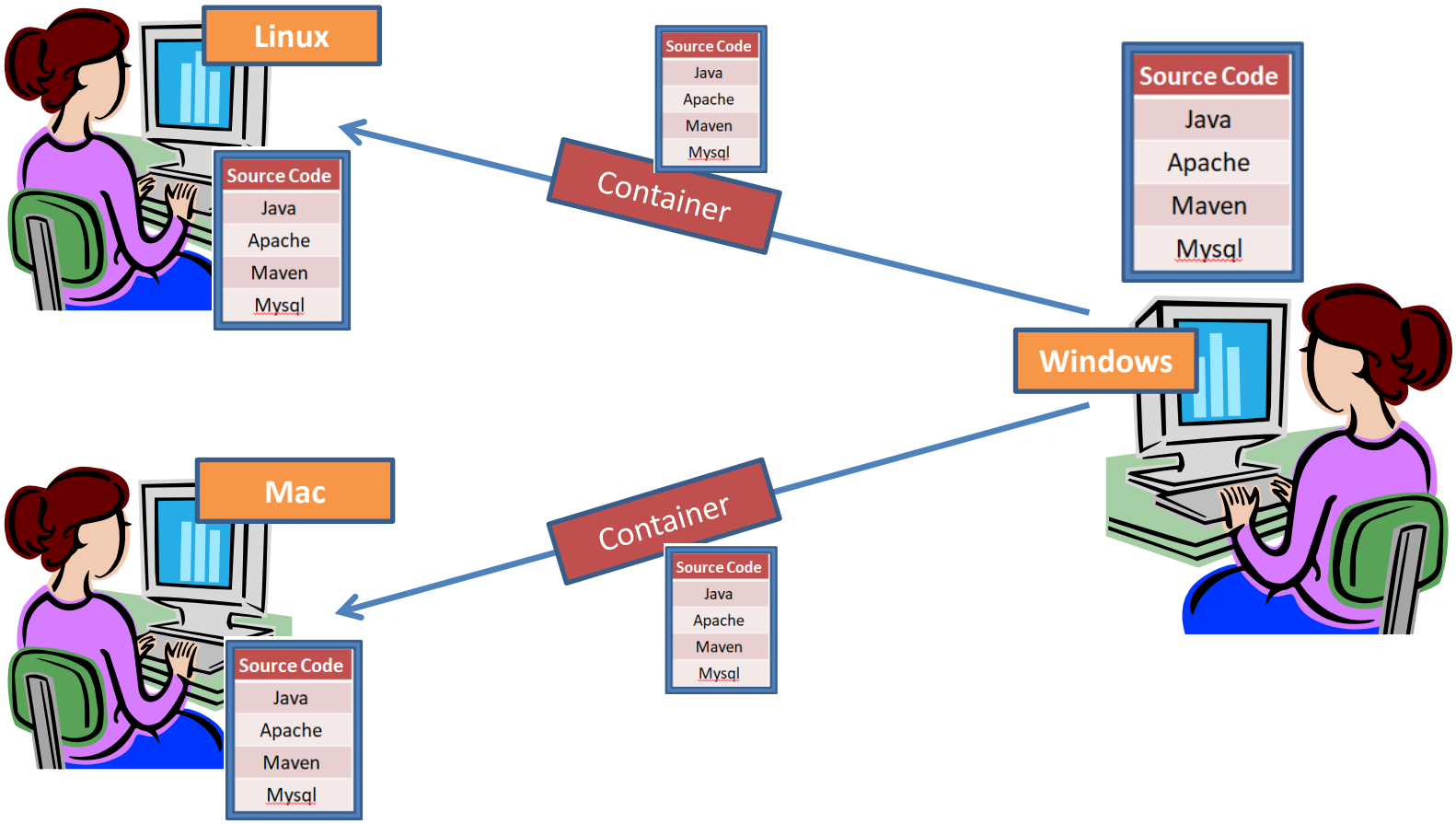




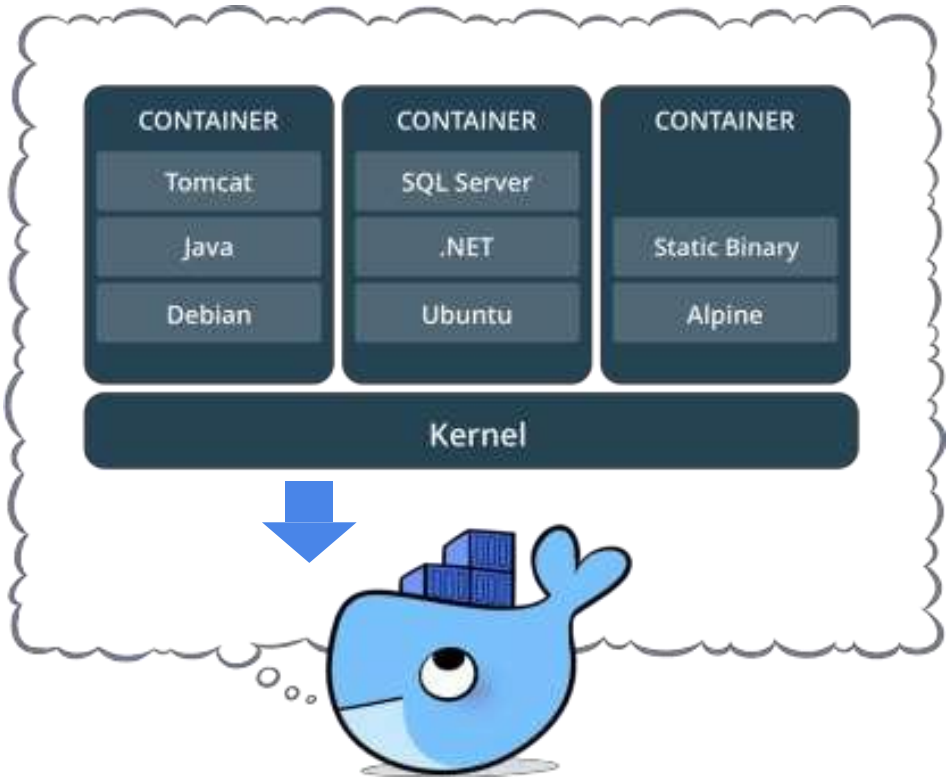
Why Docker?


Linux
Source Code
Source Code
Source Code
Java
Apache
Maven
Mysql
Windows
Mac
Source Code
Source Code

Containerization



What is a container?

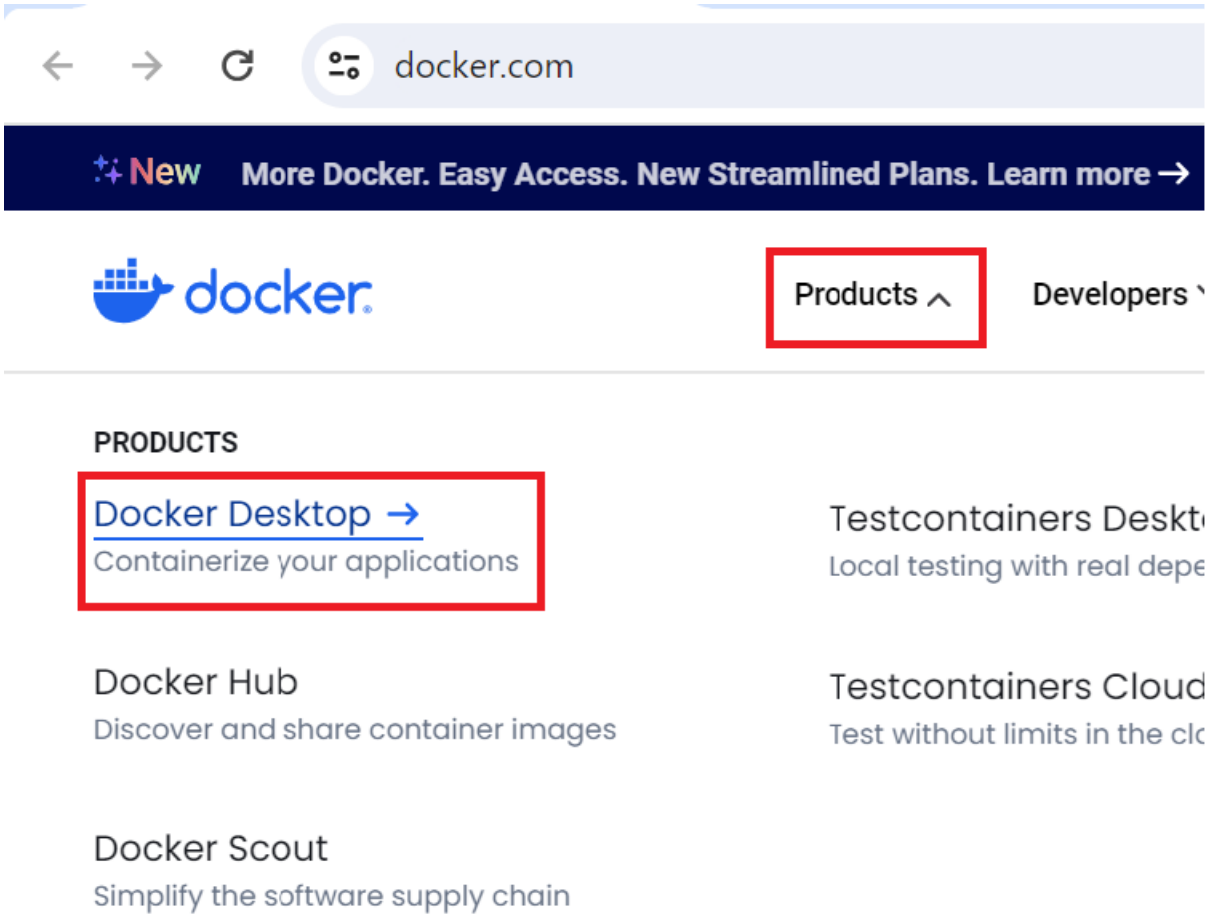


- Standardized packaging for software and dependencies
- Isolate apps from each other
- Share the same OS kernel
- Works with all major Linux and Windows Server

Docker Installation

- Docker is been created for Linux, and it will run on linux directly
- For windows, we need HyperV/WSL
- For Mac, We need Hyperkit

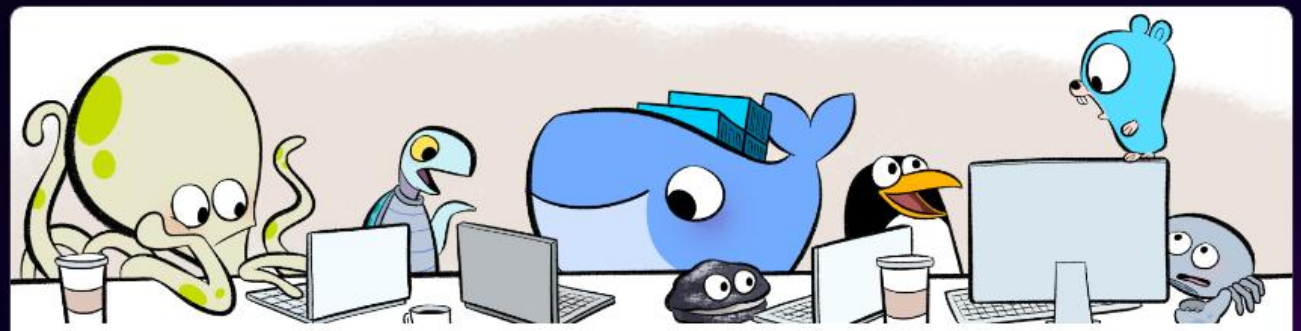
Docker Desktop



Download & Install

Recycle Bin

Docker Desktop



Docker Subscription Service Agreement

By selecting **accept**, you agree to the Subscription Service Agreement, the Docker Data Processing Agreement, and the Data Privacy Policy.

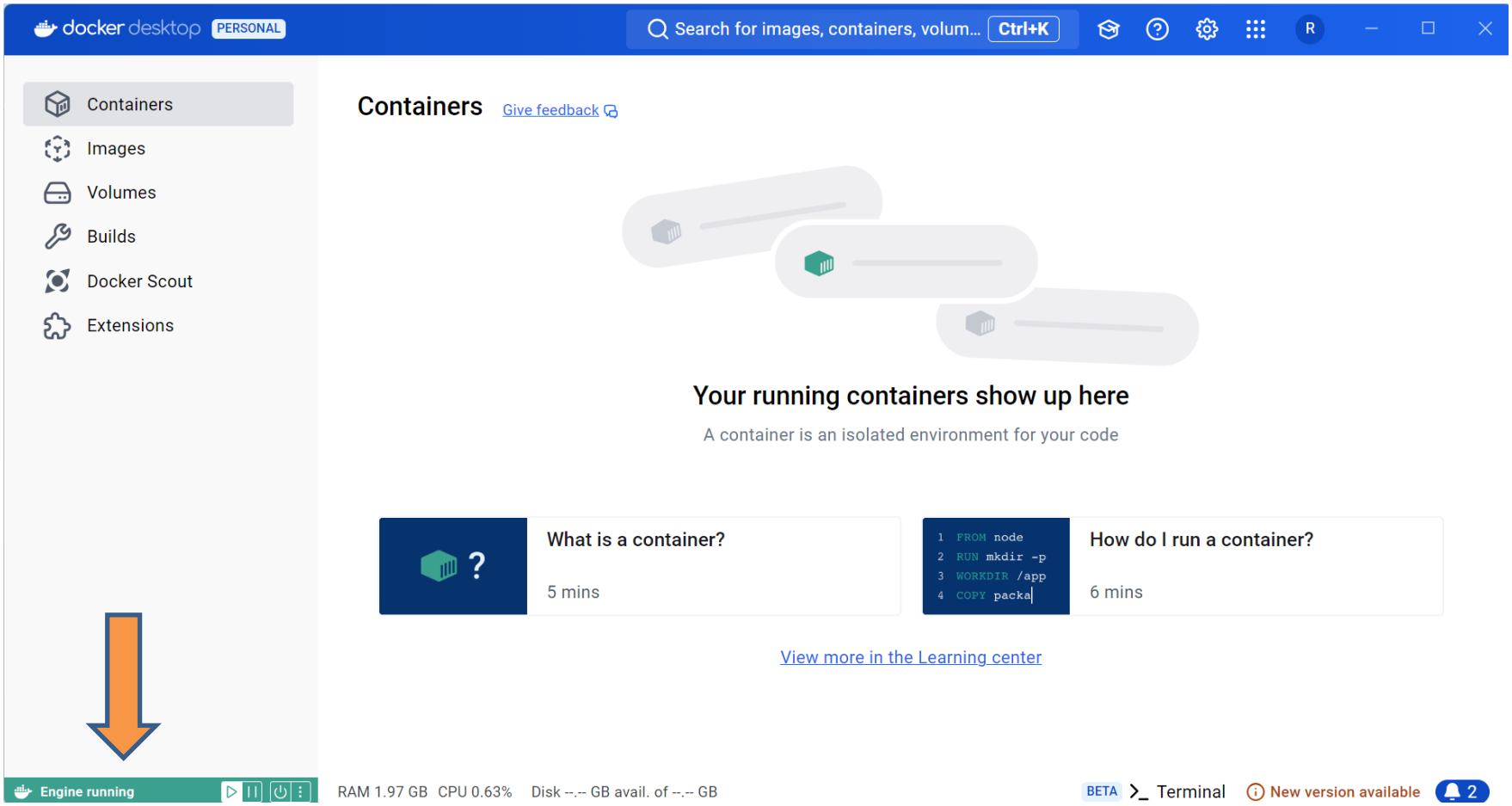
Commercial use of Docker Desktop at a company of more than 250 employees OR more than $10 million in annual revenue requires a paid subscription (Pro, Team, or Business). See subscription details

View Full Terms

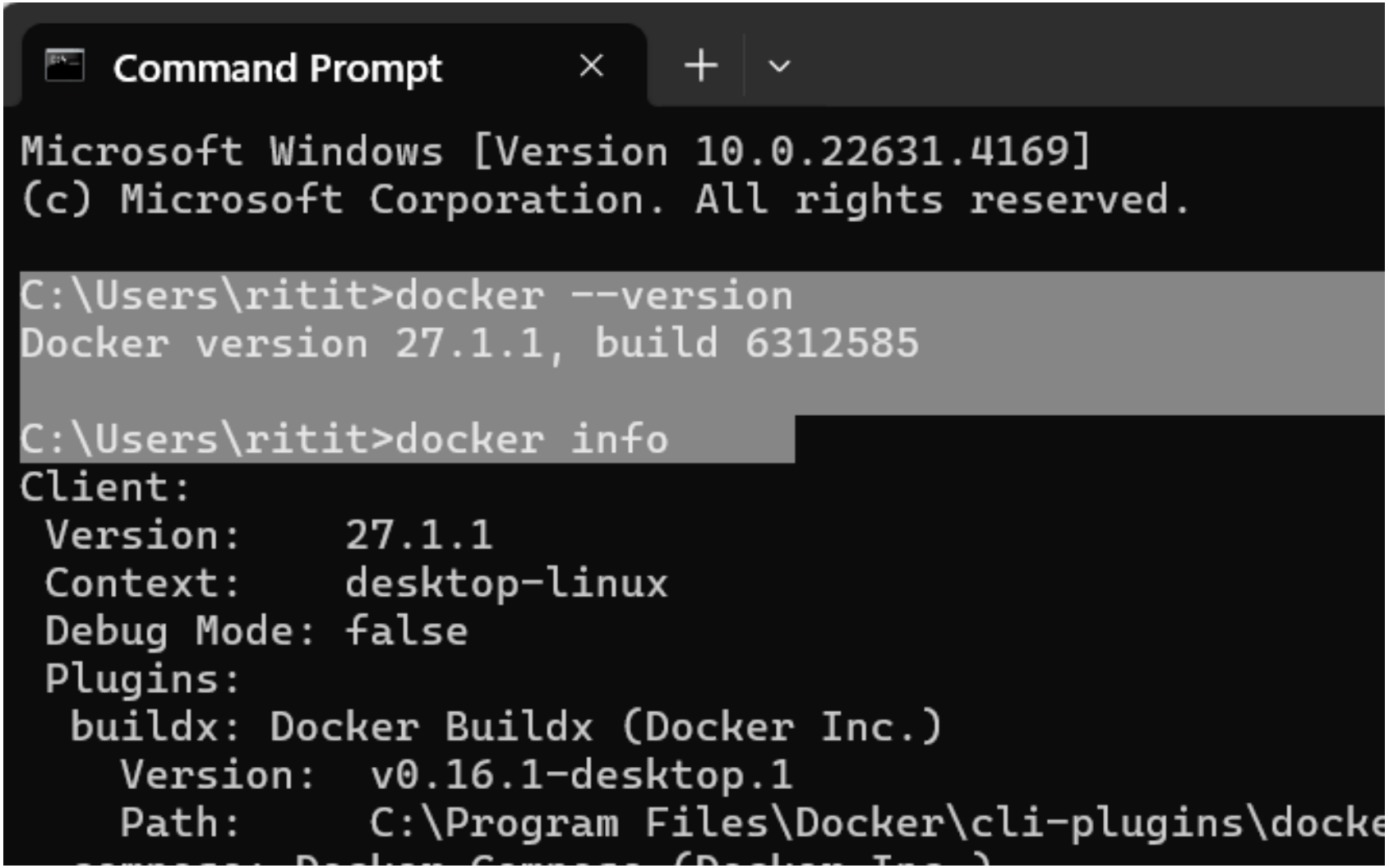
Accept

Close

Docker Engine is Started



Confirm it with cmd



DOCKER IMAGE

Docker Image

A **Docker image** is a lightweight, stand-alone, and executable package that includes everything needed to run a piece of software, including the code, runtime, libraries, dependencies, and environment configurations.

- **Docker Image**: A blueprint or template for creating containers.
- **Docker Container**: A running instance of a Docker image.

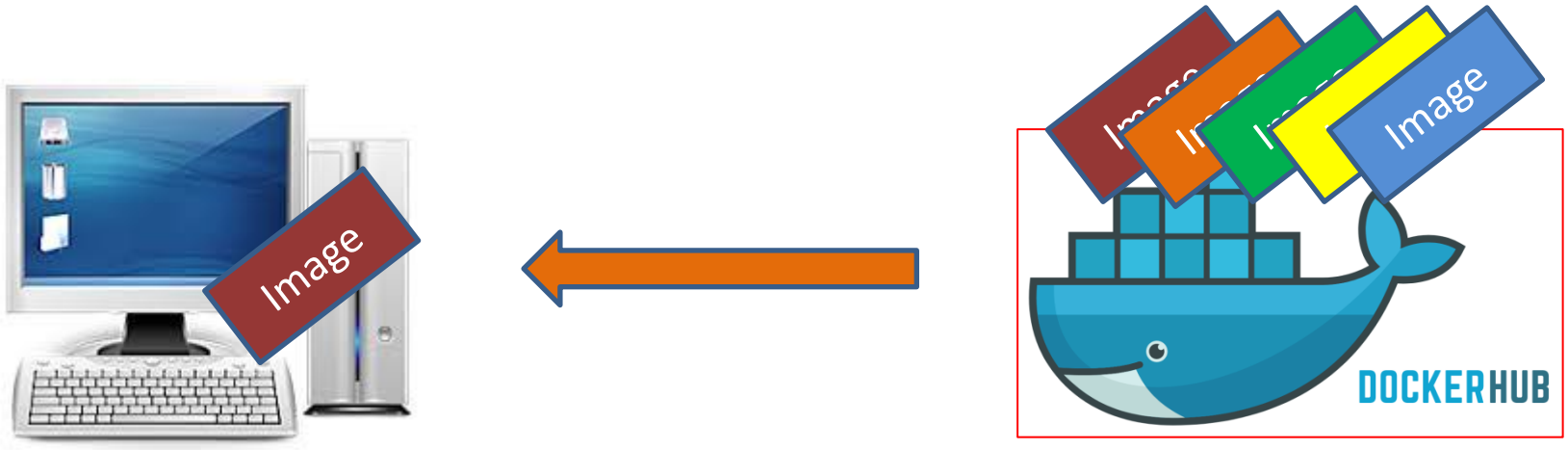
Docker Image?

Software Application

Image

Image Creation

Docker Hub

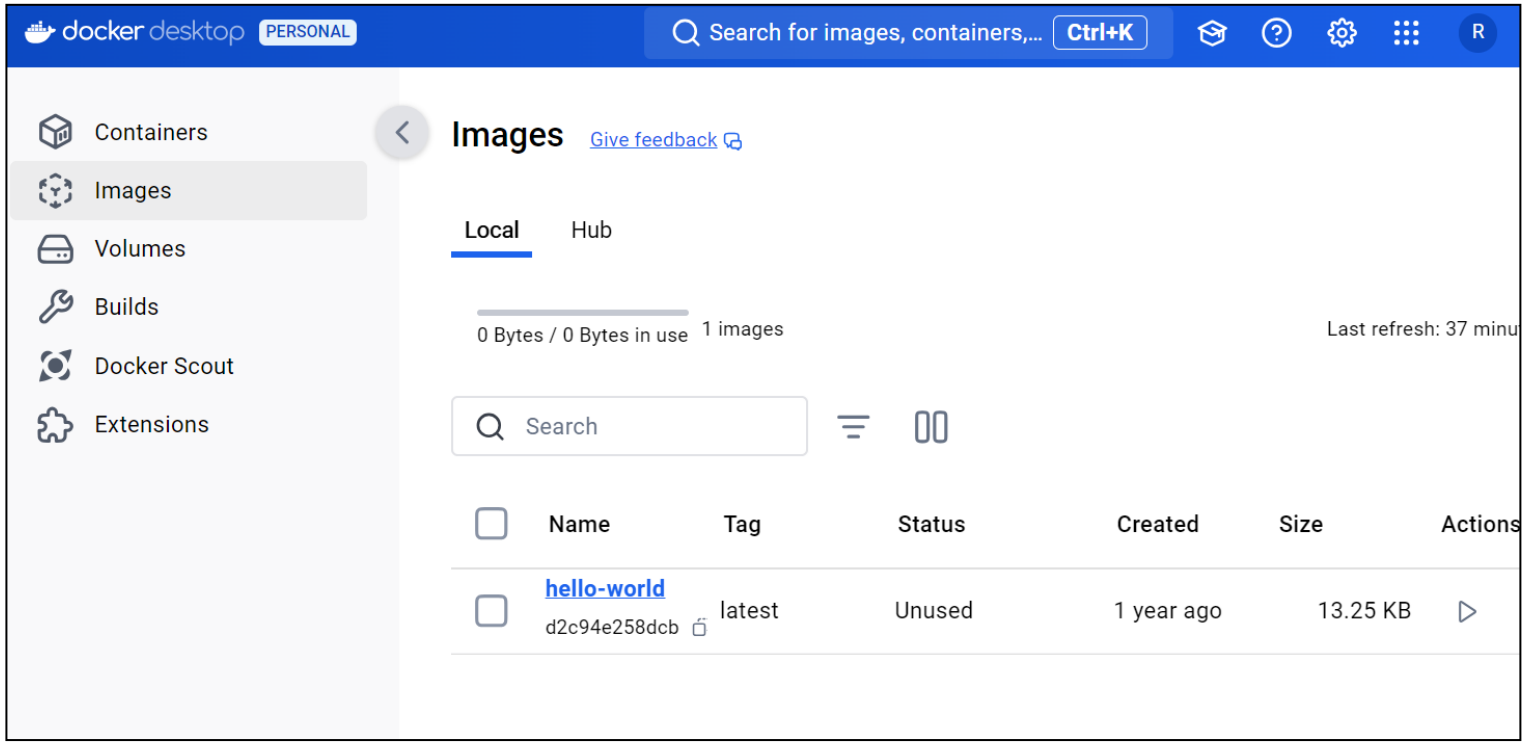


Pulling an image from Hub

```
F:\Docker>docker pull hello-world
Using default tag: latest
latest: Pulling from library/hello-world
c1ec31eb5944: Pull complete
Digest: sha256:91fb4b041da273d5a3273b6d587d62d518
Status: Downloaded newer image for hello-world:la
docker.io/library/hello-world:latest

F:\Docker>
```

Show Image

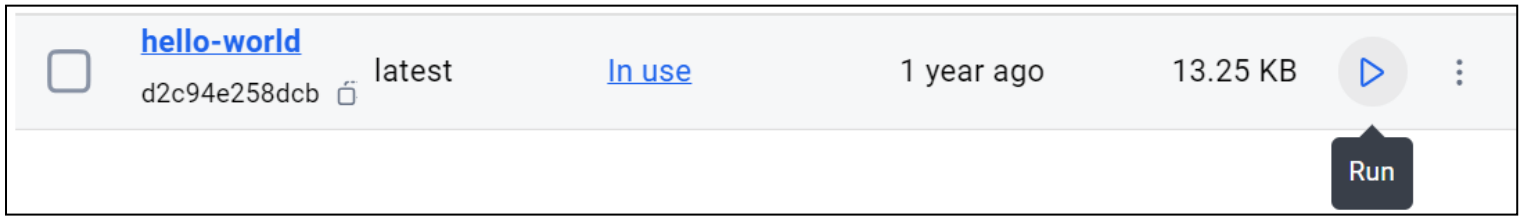
```
F:\Docker>docker images
REPOSITORY    TAG       IMAGE ID       CREATED          SIZE
hello-world   latest    d2c94e258dcb   16 months ago    13.3kB

F:\Docker>
```

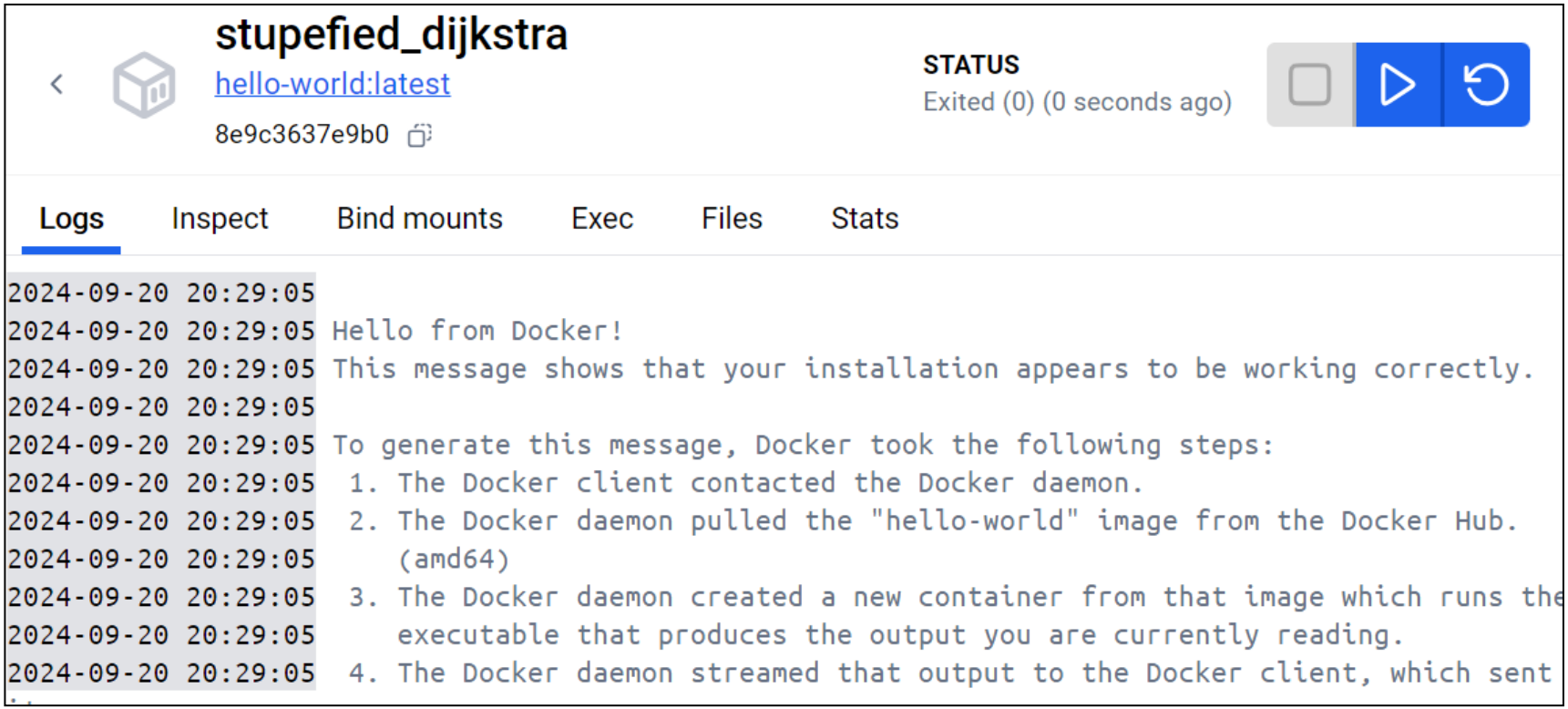


Run an image in cmd

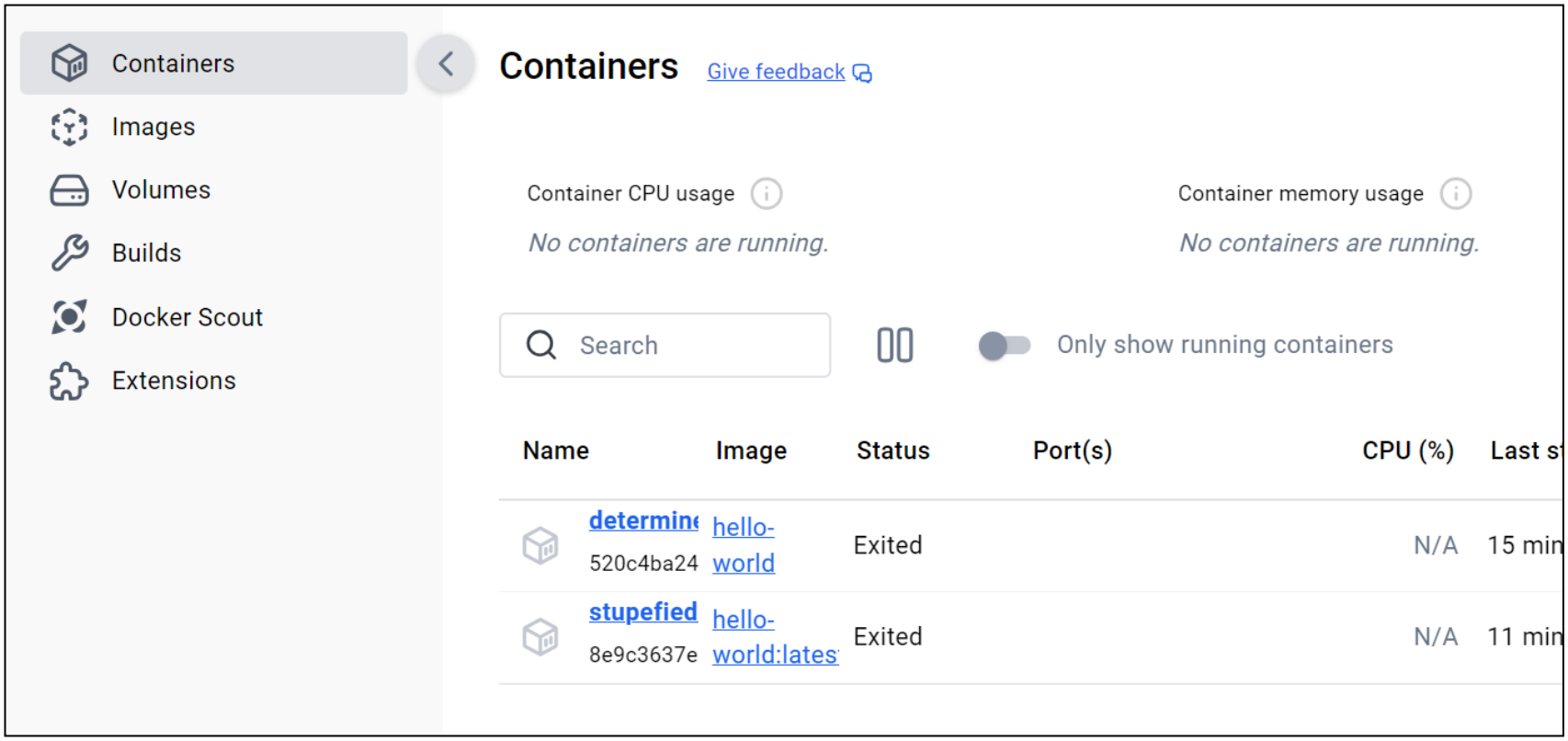
```
F:\Docker>docker run hello-world

Hello from Docker!
This message shows that your installation appears to be working correctly.

To generate this message, Docker took the following steps:
 1. The Docker client contacted the Docker daemon.
 2. The Docker daemon pulled the "hello-world" image from the Docker Hub.
    (amd64)
 3. The Docker daemon created a new container from that image which runs the
    executable that produces the output you are currently reading.
 4. The Docker daemon streamed that output to the Docker client, which sent it
    to your terminal.

To try something more ambitious, you can run an Ubuntu container with:
 $ docker run -it ubuntu bash

Share images, automate workflows, and more with a free Docker ID:
 https://hub.docker.com/

For more examples and ideas, visit:
 https://docs.docker.com/get-started/


F:\Docker>
```

Run an image in GUI





Docker Container



Container List in cmd

- docker ps will show running containers
- docker ps –a will list exited containers

```
F:\Docker>docker ps
CONTAINER ID   IMAGE     COMMAND   CREATED   STATUS    PORTS     NAMES

F:\Docker>docker ps -a
CONTAINER ID   IMAGE                 COMMAND    CREATED          STATUS
8e9c3637e9b0   hello-world:latest    "/hello"   16 minutes ago   Exited (0) 5
520c4ba242e5   hello-world           "/hello"   19 minutes ago   Exited (0) 9

F:\Docker>
```

First Image

- Create a folder
- Add a file “Dockerfile” without extension in it
- Add instruction in the dockerfile
- Build the docker image in terminal
  - **docker build –t myfirstimage .**
  - (here the “.” refers current directory)
- To run the docker image
  - **docker run myfirstimage**

Dockerfile

```
#Download base image from hub
#light weight linux
FROM alpine:latest

#Execute the command in linux
CMD [ "echo", "Welcome to Docker" ]

```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

```
PS F:\Docker\Workspace> docker build -t myfirstimage .
[+] Building 4.0s (6/6) FINISHED
 => [internal] load build definition from Dockerfile
 => => transferring dockerfile: 181B
 => [internal] load metadata for docker.io/library/alpine:latest
 => [auth] library/alpine:pull token for registry-1.docker.io
```

```
PS F:\Docker\Workspace> docker run myfirstimage
Welcome to Docker
```

CREATE AN IMAGE WITH NODEJS


nodejs.org/en
Learn
About
Download
Blog
Docs
Certification
Discover
TypeScript in Node.js
Run JavaScript Everywhere
Node.js® is a free, open-source, cross-platform JavaScript runtime environment that lets developers create servers, web apps, command

Pull nodejs image

```
F:\Docker>docker pull node
Using default tag: latest
latest: Pulling from library/node
8cd46d290033: Pull complete
2e6afa3f266c: Pull complete
2e66a70da0be: Pull complete
1c8ff076d818: Pull complete
71a2ad2ab1a1: Pull complete
8ed09065f016: Pull complete
8cc9946ce160: Pull complete
fa87db89e50a: Pull complete
Digest: sha256:cbe2d5f94110cea9817dd8c5809d05df49b4bd1a
Status: Downloaded newer image for node:latest
docker.io/library/node:latest

F:\Docker>
```

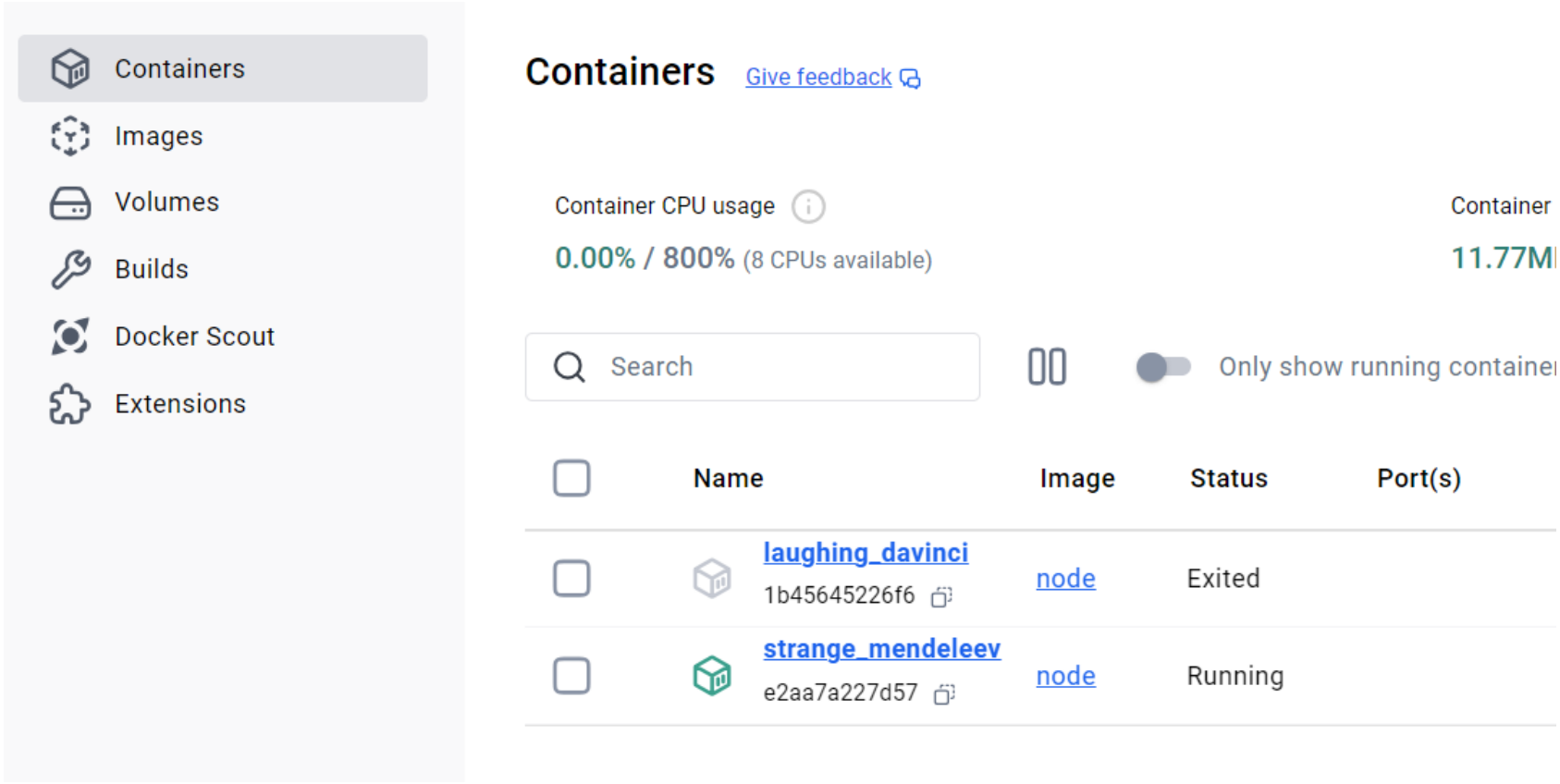
Run node image to start container

- To run nodejs, we need to run the node image
- If we use “docker run node”, It will started and gets exited immediately, since it is not associated with an interactive terminal to work with node.
- So we have use “docker run –it node”
- –i refers interactive
- -t refers TTY (TeleTYpe – basic Input/Output)

Run node container

```
F:\Docker>docker run node

F:\Docker>docker run -it node
Welcome to Node.js v22.9.0.
Type ".help" for more information.
> a = 3
3
> b = 4
4
> console.log(a+b)
7
undefined
>
```

Running Container

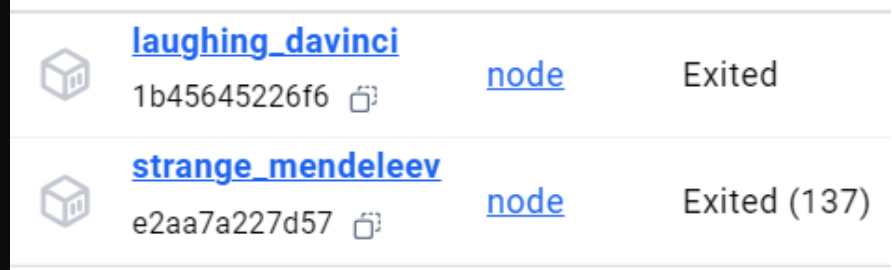


Stop a Container

- To stop a docker container use “**ctrl+c**”, or
- open another terminal “**docker stop <container-name/id>**”

```
PS C:\Users\ritit> docker stop strange_mendeleev
strange_mendeleev
PS C:\Users\ritit>
```

```
F:\Docker>docker run -it node
Welcome to Node.js v22.9.0.
Type ".help" for more information.
> a = 3
3
> b = 4
4
> console.log(a+b)
7
undefined
>
F:\Docker>
```



Restart a Container

- “docker start <container name/id>”
  - Container will be in running status

```
F:\Docker\Workspace>docker start strange_mendeleev
strange_mendeleev

F:\Docker\Workspace>
```

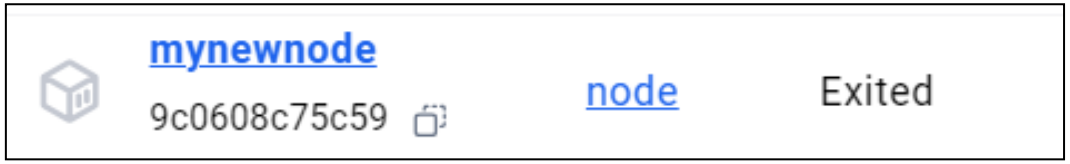
- To run commands in running container
  - docker exec –it <container> <command>

```
F:\Docker\Workspace>docker exec -it strange_mendeleev node
Welcome to Node.js v22.9.0.
Type ".help" for more information.
>
```

Named Containers

```
F:\Docker\Workspace>docker run --name mynode node

F:\Docker\Workspace>
```


```
F:\Docker\Workspace>docker rename mynode mynewnode

F:\Docker\Workspace>
```

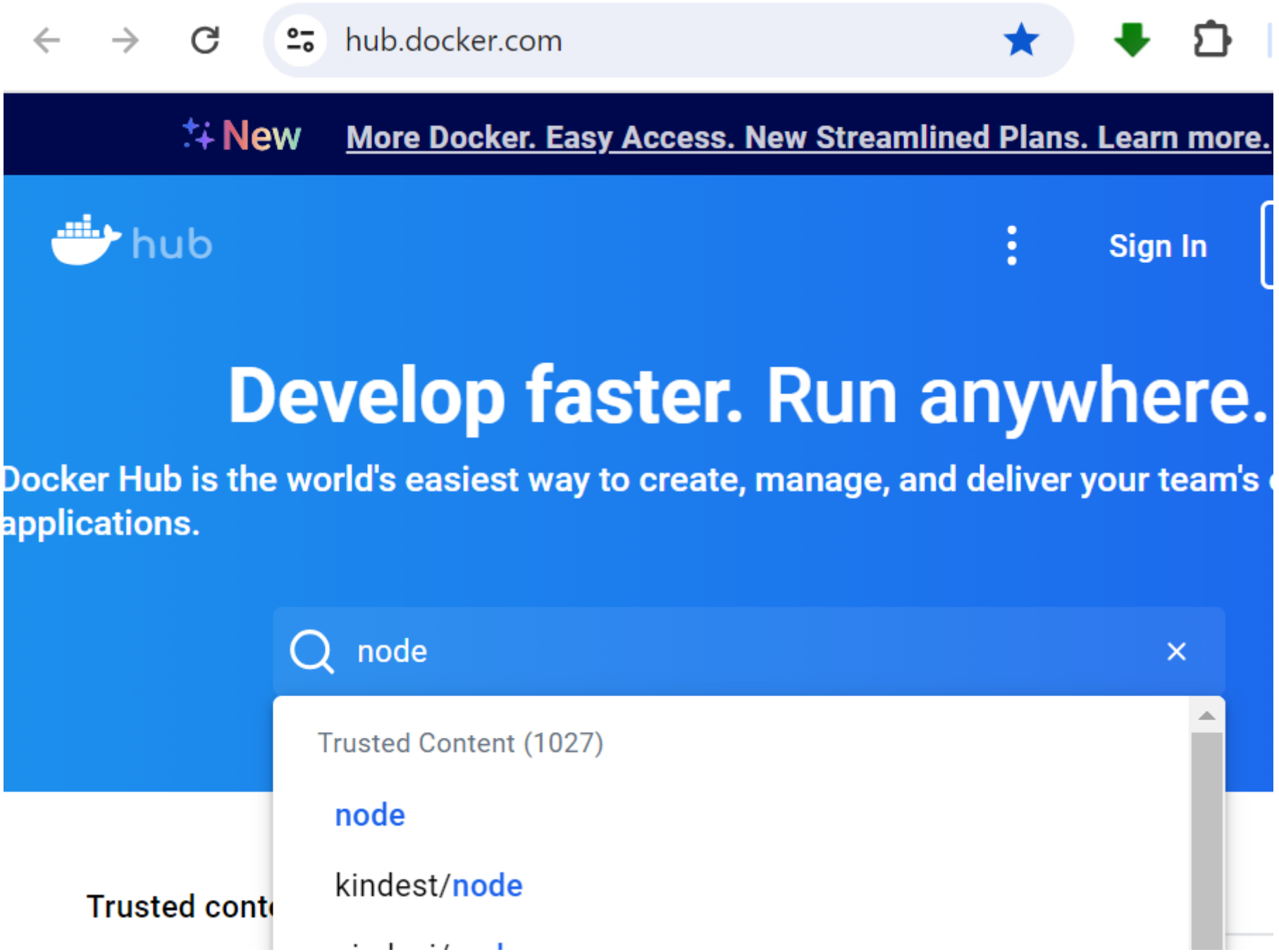


To remove all stopped containers

- docker container prune

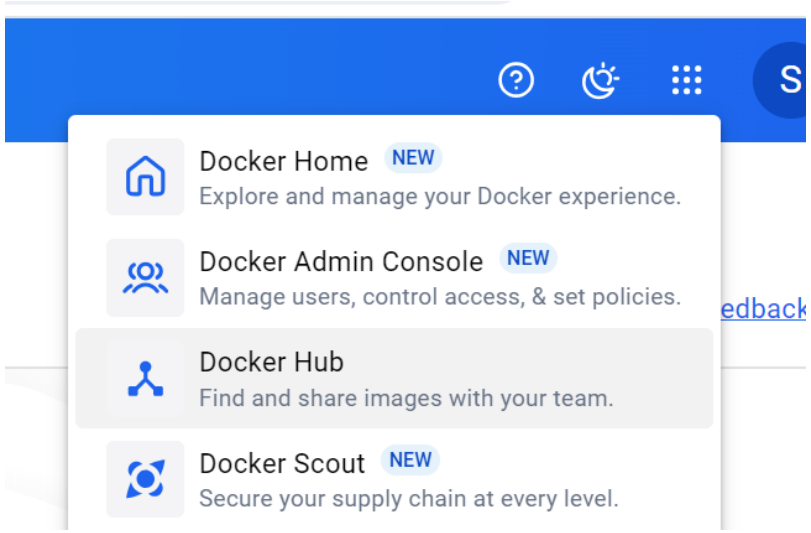
Docker Repository with official & third party images

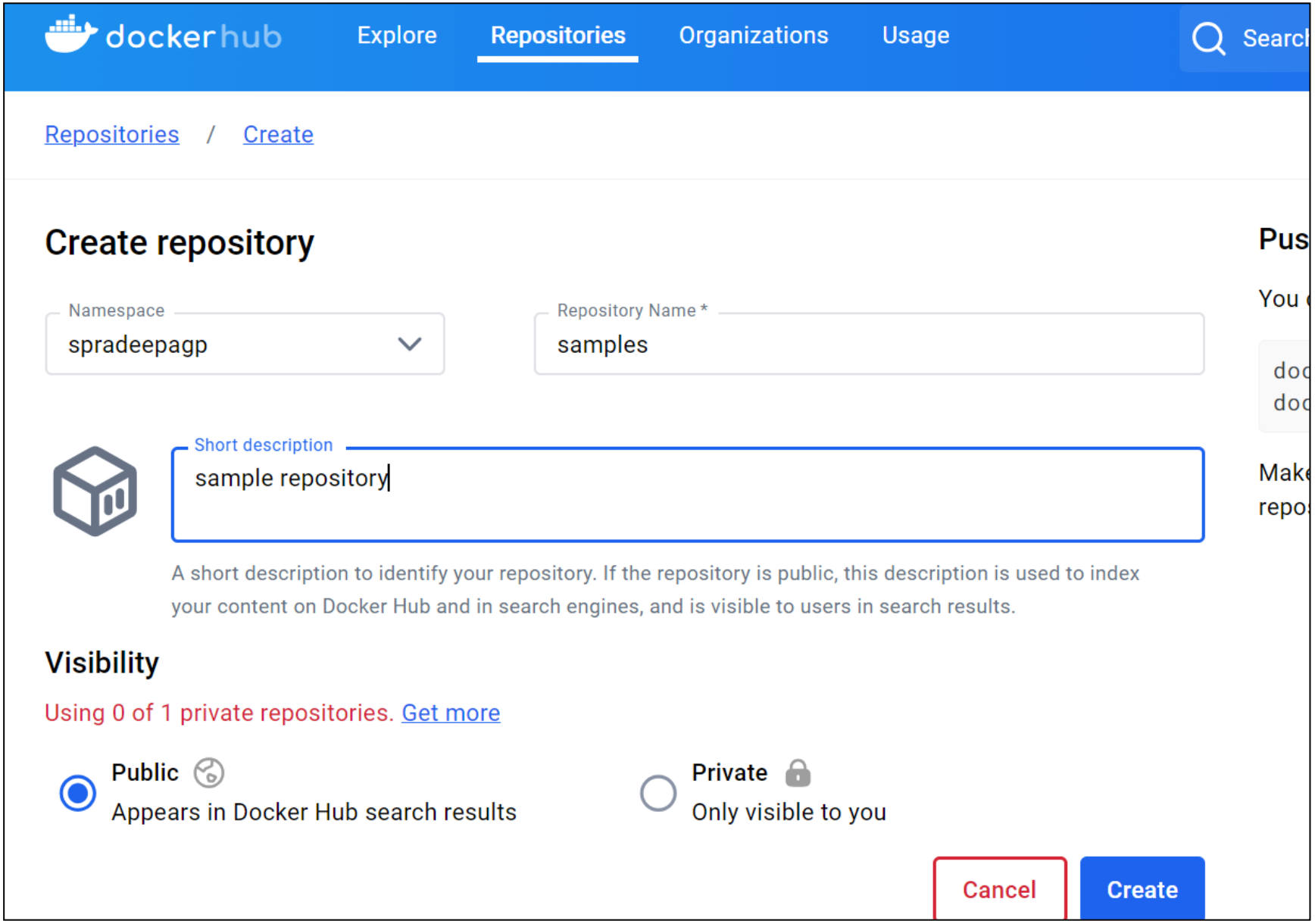
PUBLISHING DOCKER IMAGES


hub.docker.com
New
More Docker. Easy Access. New Streamlined Plans. Learn more.
hub
Sign In
Develop faster. Run anywhere.
Docker Hub is the world's easiest way to create, manage, and deliver your team's
applications.
node
Trusted Content (1027)
node
kindest/node
Trusted cont

Docker Hub

- Signup with docker
- Login with docker
- Click on Docker Hub
- Create a Repository

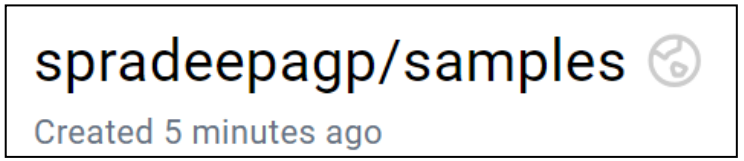



dockerhub
Explore
Repositories
Organizations
Usage
Search
Repositories / Create
Create repository
Namespace
spradeepagp
Repository Name *
samples
Short description
sample repository
A short description to identify your repository. If the repository is public, this description is used to index your content on Docker Hub and in search engines, and is visible to users in search results.
Visibility
Using 0 of 1 private repositories. Get more
Public
Appears in Docker Hub search results
Private
Only visible to you
Cancel
Create

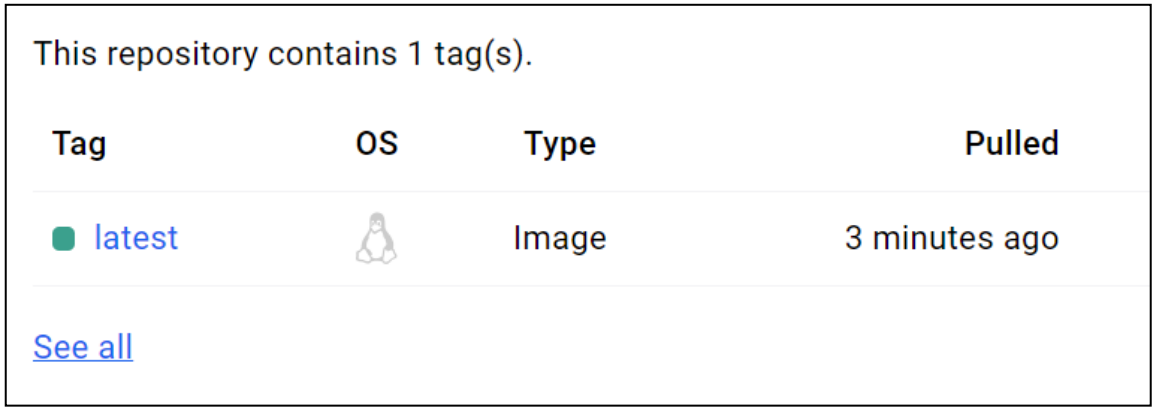
Docker login from cmd

```
PS F:\Docker\Workspace\usecase1> docker login
Log in with your Docker ID or email address to push and
cker ID, head over to https://hub.docker.com/ to create
You can log in with your password or a Personal Access T
 security and is required for organizations using SSO. L
ns/

Username: spradeepagp
Password:
Login Succeeded
PS F:\Docker\Workspace\usecase1>
```

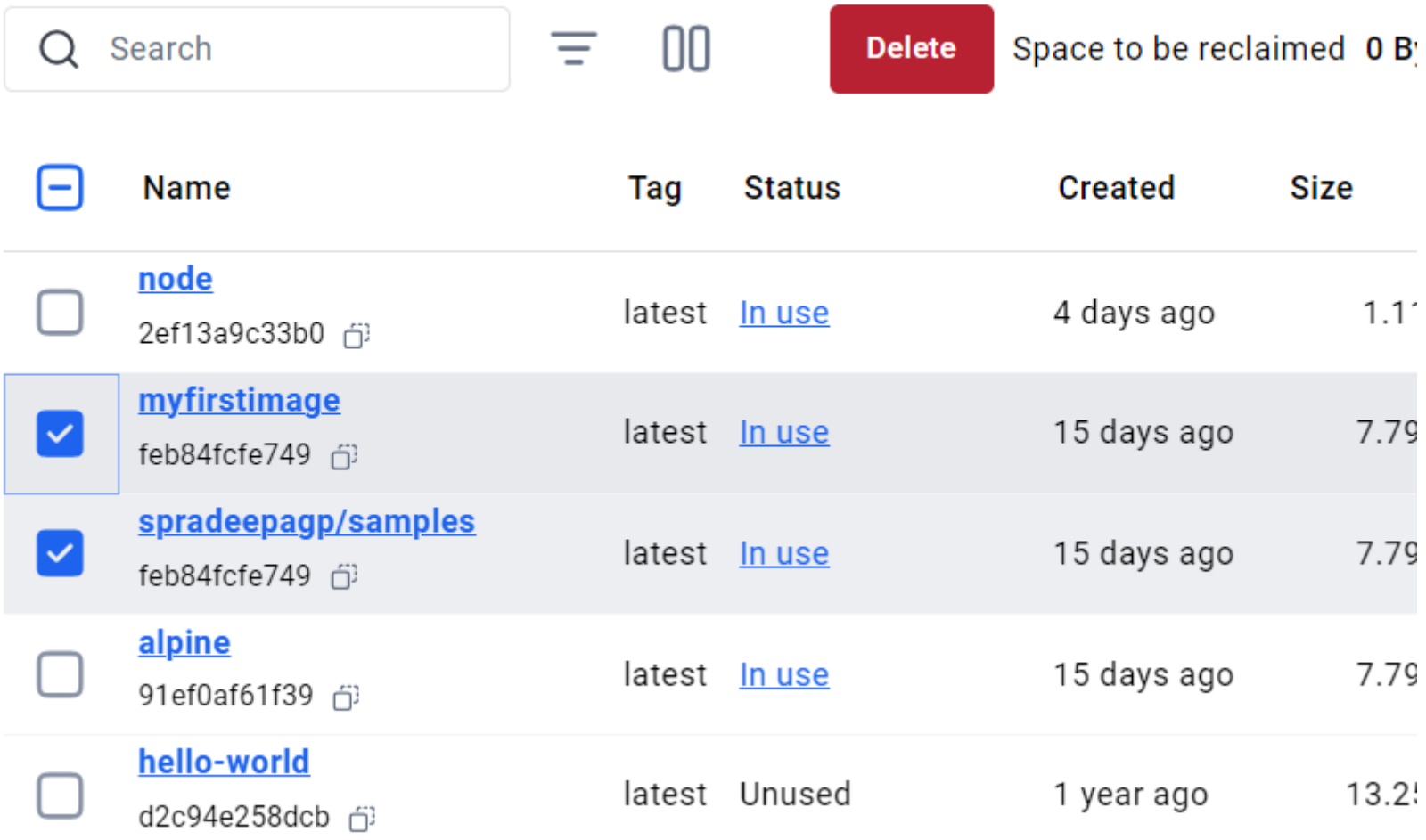
Push image to repository




```
Login Succeeded
PS F:\Docker\Workspace\usecase1> docker tag myfirstimage spradeepagp/samples:latest
PS F:\Docker\Workspace\usecase1> docker push spradeepagp/samples:latest
The push refers to repository [docker.io/spradeepagp/samples]
63ca1fbb43ae: Mounted from library/alpine
latest: digest: sha256:19a0d6dcbda818b738aa8b644991be0107ca876c64b956c19cee520c1b470b
PS F:\Docker\Workspace\usecase1>
```



Delete images from docker desktop



Pull the image

Name	Tag	Status	Created	Size	Actions
node 2ef13a9c33b0	latest	In use	4 days ago	1.11 GB	
alpine 91ef0af61f39	latest	In use	15 days ago	7.79 MB	
hello-world d2c94e258dcb	latest	Unused	1 year ago	13.25 KB	

```
PS F:\Docker\Workspace\usecase1> docker pull spradeepagp/samples:latest
latest: Pulling from spradeepagp/samples
```

alpine 91ef0af61f39	latest	In use	15 days ago	7.79 MB	
spradeepagp/samples feb84fcfe749	latest	Unused	15 days ago	7.79 MB	
hello-world d2c94e258dcb	latest	Unused	1 year ago	13.25 KB	

Run the image

```
PS F:\Docker\Workspace\usecase1> docker run -it spradeepagp/samples
Welcome to Docker
PS F:\Docker\Workspace\usecase1>
```

SPRING BOOT + DOCKERFILE

Dockerfile

A **Dockerfile** is a text file that contains instructions to **build a Docker image** — like a recipe that tells Docker how to create an environment for your application.

Think of it like:

> "*Hey Docker, here's what you need to do:*
> *Start from this base image,*
> *install some things,*
> *copy my code in,*
> *and then run my app*."

Dockerfile

A Dockerfile is a step-by-step script that tells Docker how to build an image. For a **Java app**, here are the **essential components**:

1. Base Image
2. Set Working Directory (Optional but Recommended)
3. Copy the Compiled Java App (JAR File)
4. Define How to Run the App
5. (Optional) Expose Port

1. **Base Image**

   This is the environment that your Java app needs to run.

   FROM openjdk:17-jdk-slim

   This line means: "Start from a lightweight Linux image that already has Java 17 installed."

2. **Set Working Directory** (Optional but Recommended)

   WORKDIR /app

   This sets /app as the folder where your app will live inside the container.

3. Copy the Compiled Java App (JAR File)

You copy your .jar file into the container. Assuming you already built it using Maven:

```
ARG JAR_FILE=target/*.jar
COPY ${JAR_FILE} app.jar
```

Or, if you want to hardcode it:

```
COPY target/myapp.jar app.jar
```

4. Define How to Run the App

This tells Docker what command to run when the container starts:

```
ENTRYPOINT ["java", "-jar", "app.jar"]
```

Or if you're using CMD:

```
CMD ["java", "-jar", "app.jar"]
```

Both work, but ENTRYPOINT is more consistent for Docker best practices.

5. (Optional) Expose Port

- If your Java app listens on a specific port (e.g., 8080 for Spring Boot):
- EXPOSE 8080
- Note: This doesn't actually publish the port — it's just documentation. You still need to use -p when running the container:
- docker run -p 8080:8080 my-app

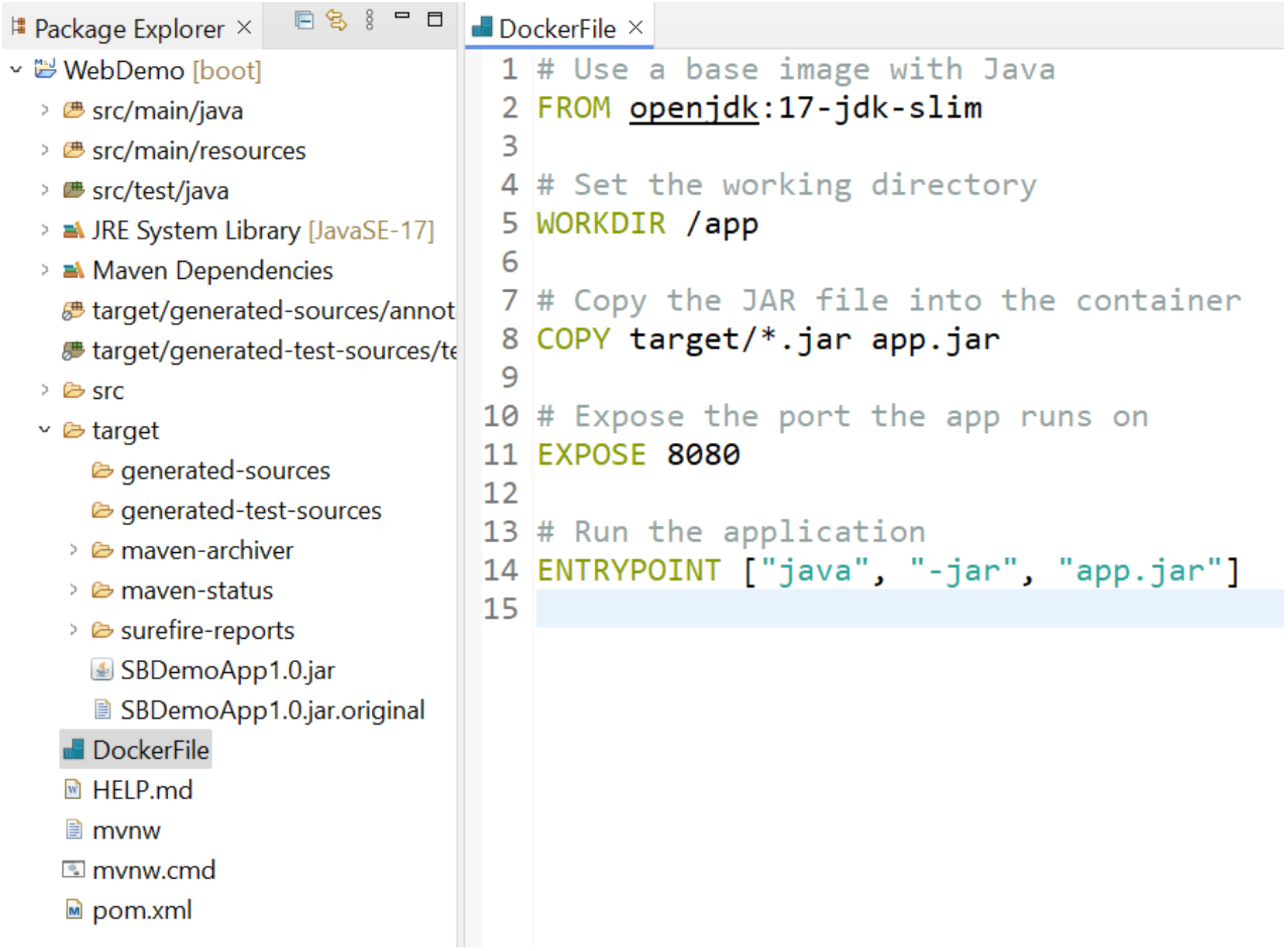
Dockerfile for SpringBoot

```
# Use Java 17 as base image
FROM openjdk:17-jdk-slim

# Set the working directory inside the container
WORKDIR /app

# Copy the JAR file built by Maven
ARG JAR_FILE=target/*.jar
COPY ${JAR_FILE} app.jar

# Optional: Expose port used by Spring Boot
EXPOSE 8080

# Run the app
ENTRYPOINT ["java", "-jar", "app.jar"]
```

Spring boot + Docker

- Create a spring boot application
- Create a jar
  - with Run As -> Maven Install
- Create a Dockerfile
  - in the project root dir
  - with the following content.

```
FROM openjdk:17-jdk-slim
WORKDIR /app
COPY target/*.jar app.jar
EXPOSE 8080
ENTRYPOINT ["java", "-jar", "app.jar"]
```


Package Explorer
WebDemo [boot]
src/main/java
src/main/resources
src/test/java
JRE System Library [JavaSE-17]
Maven Dependencies
target/generated-sources/annot
target/generated-test-sources/te
src
target
generated-sources
generated-test-sources
maven-archiver
maven-status
surefire-reports
SBDemoApp1.0.jar
SBDemoApp1.0.jar.original
DockerFile
HELP.md
mvnw
mvnw.cmd
pom.xml
DockerFile
1 # Use a base image with Java
2 FROM openjdk:17-jdk-slim
3
4 # Set the working directory
5 WORKDIR /app
6
7 # Copy the JAR file into the container
8 COPY target/*.jar app.jar
9
10 # Expose the port the app runs on
11 EXPOSE 8080
12
13 # Run the application
14 ENTRYPOINT ["java", "-jar", "app.jar"]
15

Workflow with Maven

Open a terminal in the project root location

- Package your app:
  - mvn clean package
- Build Docker image:
  - docker build -t spradeepagp/sbdemoapp:latest .
- Run the container:
  - docker run -p 8080:8080 spradeepagp/sbdemoapp:latest
- Access the api:
  - Visit http://localhost:8080/hello

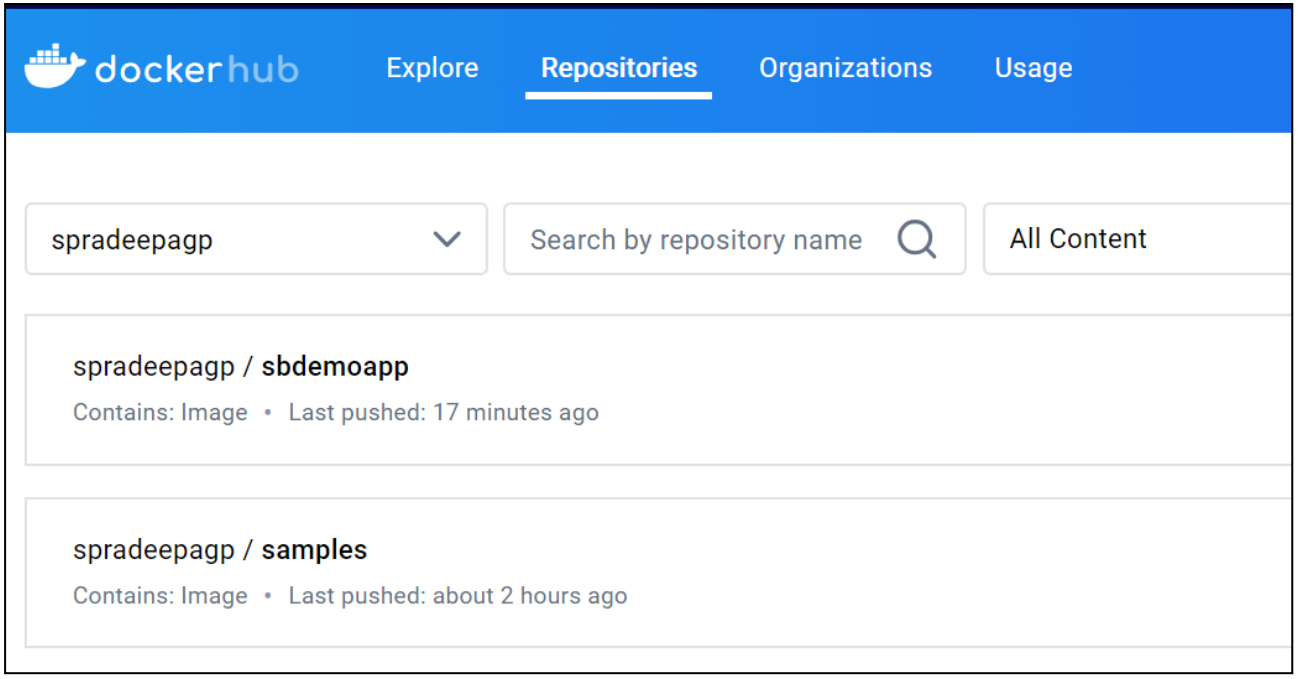
Docker Image Push

- Log in to Docker Hub
  - docker login
- Push the Docker Image to Docker Hub
  - docker push spradeepagp/sbdemoapp:latest

Open terminal and type below

```
F:\WebDemo>docker build -t spradeepagp/sbdemoapp:latest .
[+] Building 27.6s (9/9) FINISHED
....

F:\WebDemo>docker login
Authenticating with existing credentials...
Login Succeeded

F:\WebDemo>docker push spradeepagp/sbdemoapp:latest
The push refers to repository [docker.io/spradeepagp/sbdemoapp]
d56ac6ab8fe9: Pushed
....

F:\WebDemo>docker run -p 8080:8080 spradeepagp/sbdemoapp:latest


  .   ____          _            __ _ _
 /\\ / ___'_ __ _ _(_)_ __  __ _ \ \ \ \
( ( )\___ | '_ | '_| | '_ \/ _` | \ \ \ \
 \\/  ___)| |_)| | | | | || (_| |  ) ) ) )
  '  |____| .__|_| |_|_| |_\__, | / / / /
 =========|_|==============|___/=/_/_/_/
```

Image in local and Hub



SPRING BOOT + DOCKER COMPOSE

Docker Compose

Docker Compose lets you define and run **multi-container** Docker applications using a **single YAML file**.

- Instead of running multiple docker run commands manually, you just define your whole app in a file, then run:
- docker-compose up

- **Typical Java App Use Case**
  - Let's say you have:
  - A **Spring Boot** app (Java) that runs in one container
  - A **MySQL** database in another container
  - You can use **Docker Compose** to run both together, networked automatically.

Docker-compose.yml

(Spring Boot + MySQL)

```
version: '3.8'

services:
  app:
    build: .
    ports:
      - "8080:8080"
    environment:
      SPRING_DATASOURCE_URL: jdbc:mysql://mysql:3306/testdb
      SPRING_DATASOURCE_USERNAME: root
      SPRING_DATASOURCE_PASSWORD: root
    depends_on:
      - mysql

  mysql:
    image: mysql:8
    ports:
      - "3306:3306"
    environment:
      MYSQL_ROOT_PASSWORD: root
      MYSQL_DATABASE: testdb
```

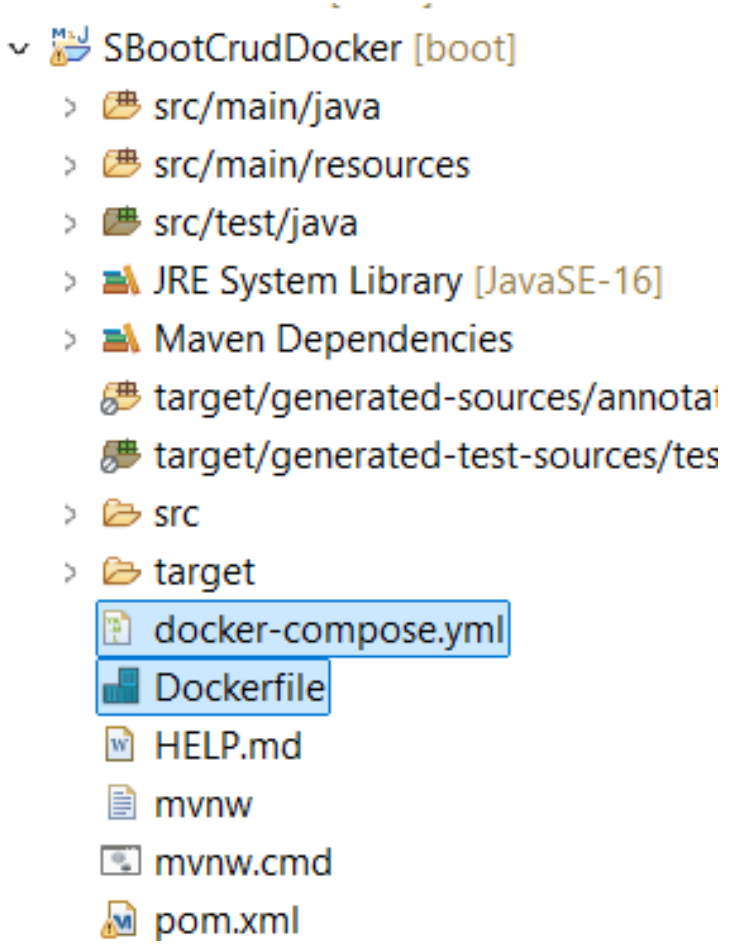
Breakdown: What Each Section Means

Section	Meaning
version: '3.8'	Compose file format version
services:	List of containers to run
app:	Your Java/Spring Boot application
build: .	Build image from Dockerfile in the current folder
ports:	Map container port to local machine (8080:8080)
environment:	Inject environment variables (used in application.properties)
depends_on:	Start MySQL before Spring Boot
mysql:	MySQL service using official image
image:	Download this Docker image from Docker Hub
MYSQL_*	MySQL container settings (passwords, database name, etc.)

Spring Boot + MySQL

Implementation Step by Step:

- Create a spring boot mysql CRUD application
- Create a Dockerfile (No extension) in the root directory
- Create a docker-compose.yml file in the root directory
- Open a terminal in the root directory
  - Create jar file
    - mvn clean package
  - Run everything
    - Docker-compose up --build
- Press ‘v’ key to view container in docker desktop



Pom.xml

SBootCrudDocker/pom.xml | application.properties | Dockerfile | docker-compose.yml

```
39          </dependency>
40      </dependencies>
41
42      <build>
43          <finalName>springboot-crud</finalName>
44          <plugins>
45              <plugin>
46                  <groupId>org.springframework.boot</groupId>
47                  <artifactId>spring-boot-maven-plugin</artifactId>
48              </plugin>
49          </plugins>
50      </build>
51
52  </project>
```

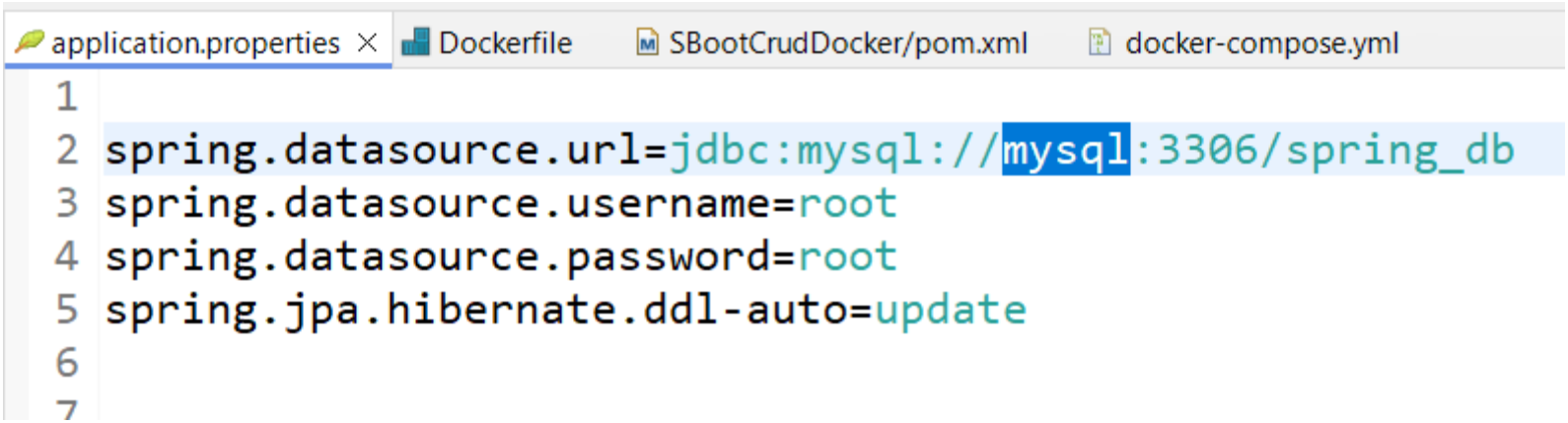
Dockerfile

SBootCrudDocker/pom.xml | Dockerfile × | application.properties | docker-compose.yr

```
1  # Use an official JDK image
2  FROM openjdk:17-jdk-slim
3
4  # Set the working directory
5  WORKDIR /app
6
7  # Copy built jar file
8  COPY target/springboot-crud.jar app.jar
9
10 # Expose the port Spring Boot runs on
11 EXPOSE 8080
12
13 # Run the application
14 ENTRYPOINT ["java", "-jar", "app.jar"]
15
```

Propeties file

- Replace localhost with mysql (container name)



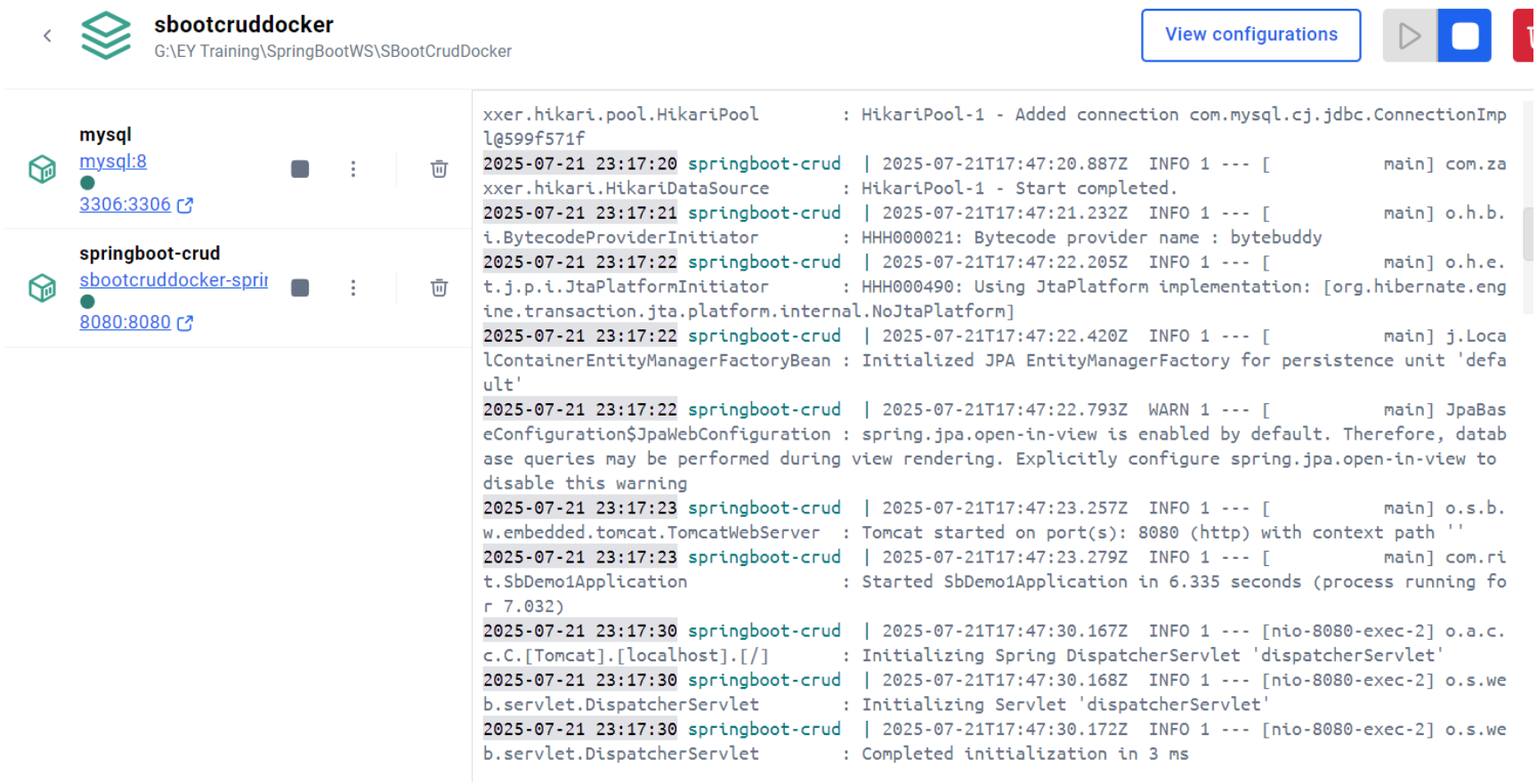
docker-compose.yml | SBootCrudDocker/pom.xml | Dockerfile | application.properties

```yaml
# docker-compose.yml - The Compose specification establishes a
version: '3.8'

services:
  mysql:
    image: mysql:8
    container_name: mysql
    ports:
      - "3306:3306"
    environment:
      MYSQL_DATABASE: mydb
      MYSQL_ROOT_PASSWORD: root
    volumes:
      - mysql_data:/var/lib/mysql

  springboot-app:
    build: .
    container_name: springboot-crud
    depends_on:
      - mysql
    ports:
      - "8080:8080"
    environment:
      SPRING_DATASOURCE_URL: jdbc:mysql://mysql:3306/mydb
      SPRING_DATASOURCE_USERNAME: root
      SPRING_DATASOURCE_PASSWORD: root

volumes:
  mysql_data:

```

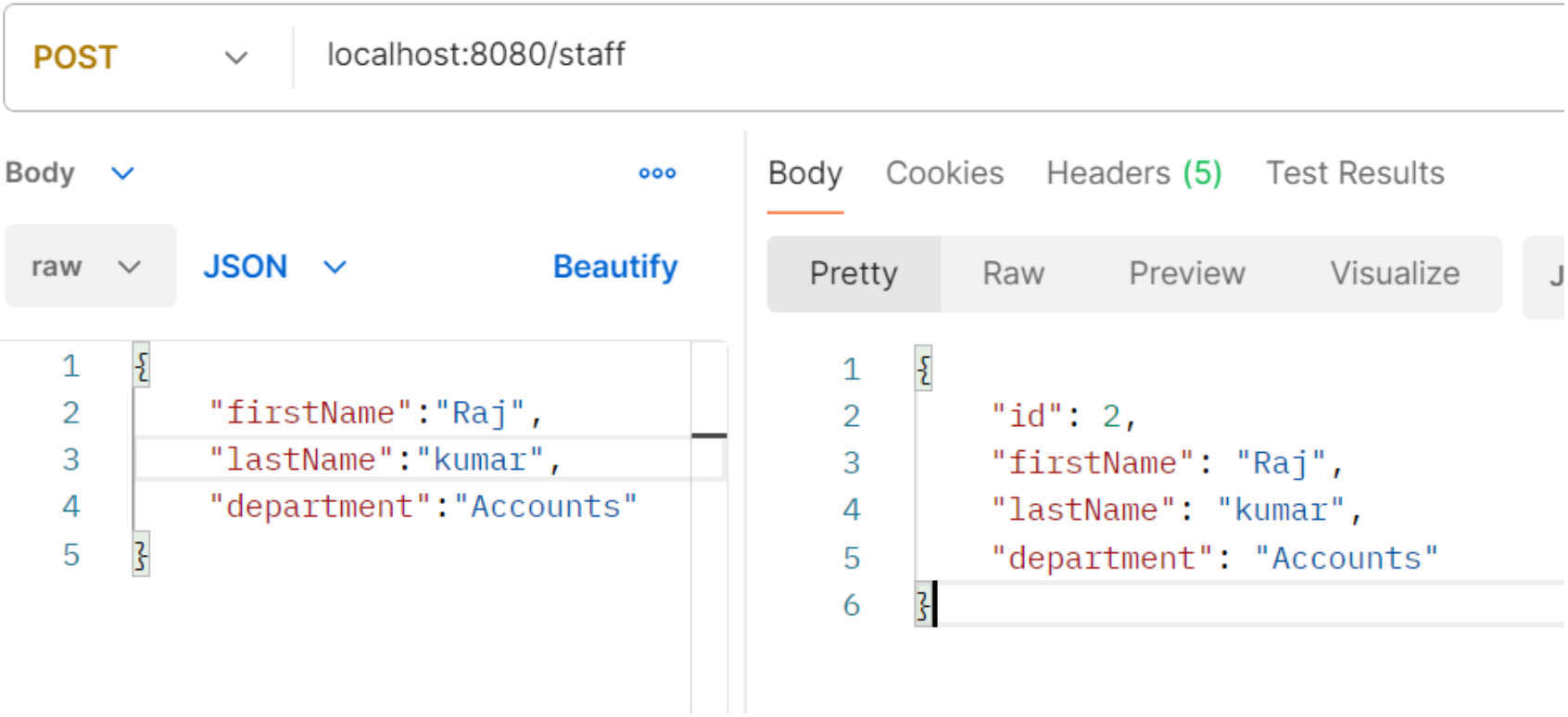
- Open a terminal in the root directory
  - Create jar file
    - mvn clean package -DskipTests
  - Run everything
    - Docker-compose up --build

- Press ‘v’ key to view container in docker desktop
- Run the application container
- Access the endpoints in the postman

Open and Run in DockerDesktop



Access it with postman



THANK YOU