Containerization with Docker

CONTAINERIZATION AND VIRTUALIZATION CONCEPTS

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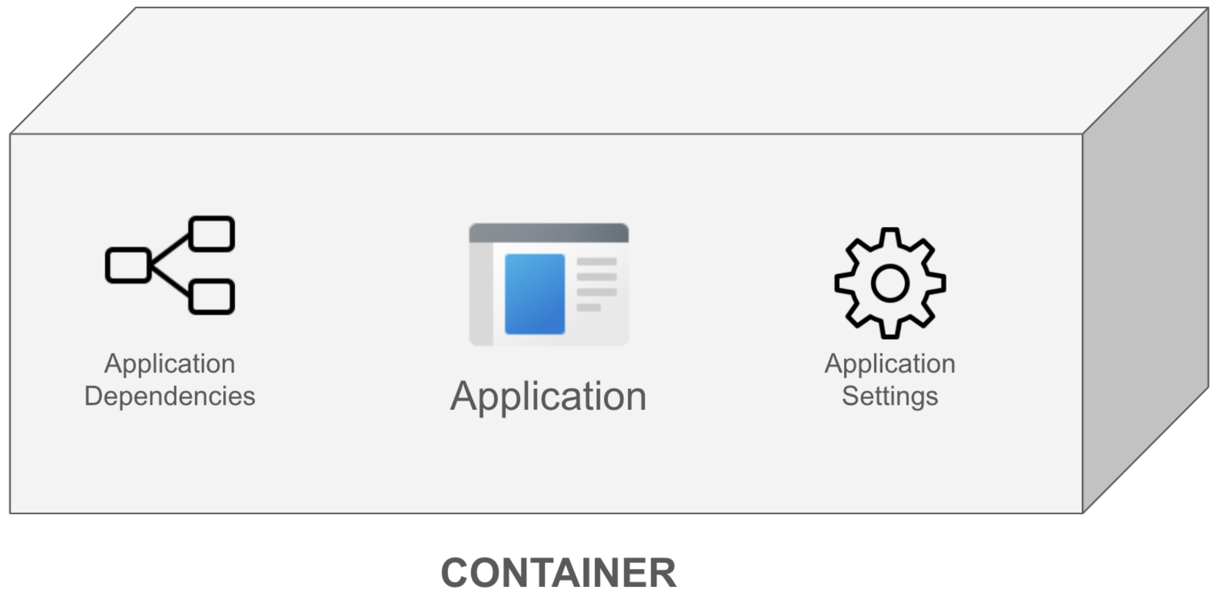
Recap: Definition of a container

- Containers
  - Isolated environment
  - Includes application and all dependencies



[1] Icons by icons8.com

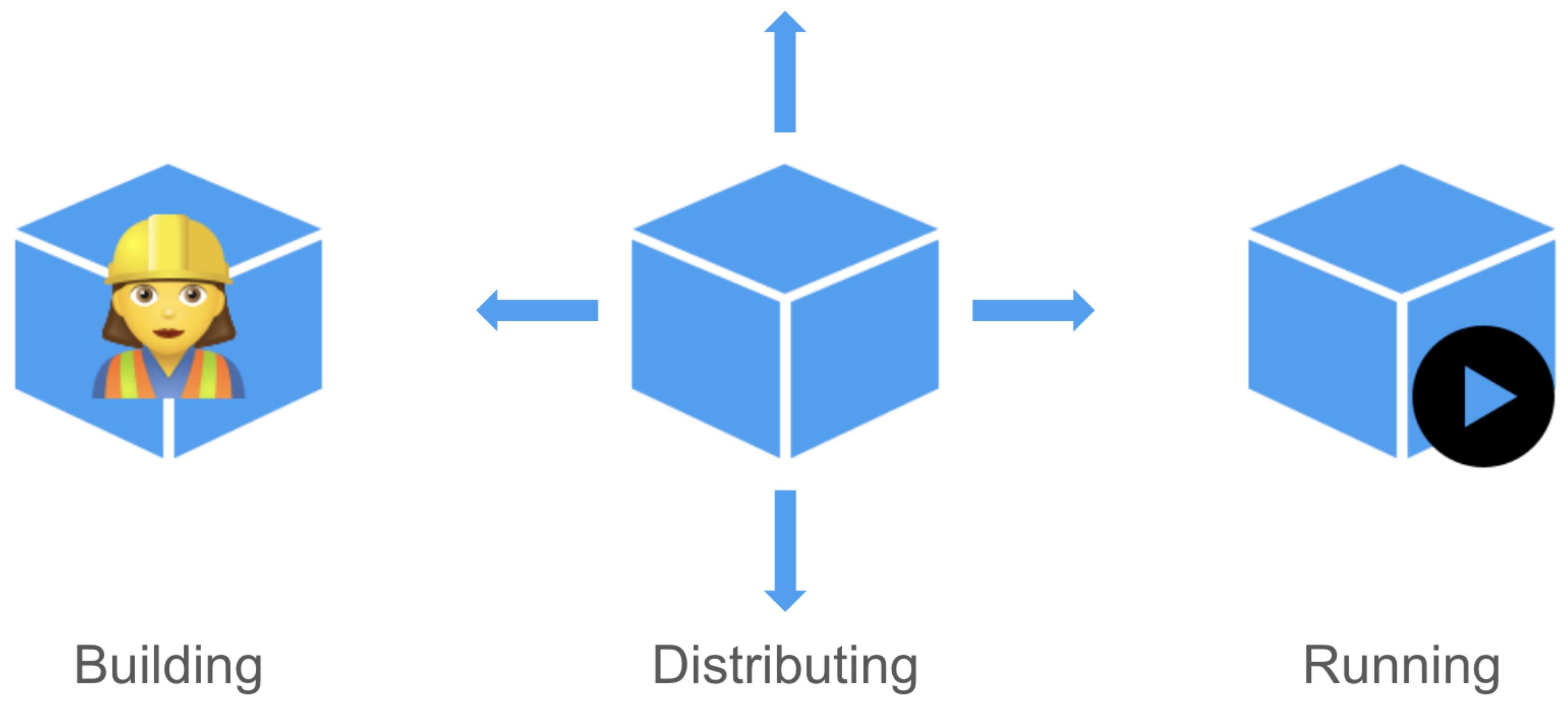
Introducing Docker

- The go-to containerization tool
- Open-source & large user base
- One of the most used and popular tools!

[1] Stack Overflow Developer Survey from 2023 [2] Logo by Docker Inc. from 2024

Introducing Docker

- Managing the lifecycle of containers

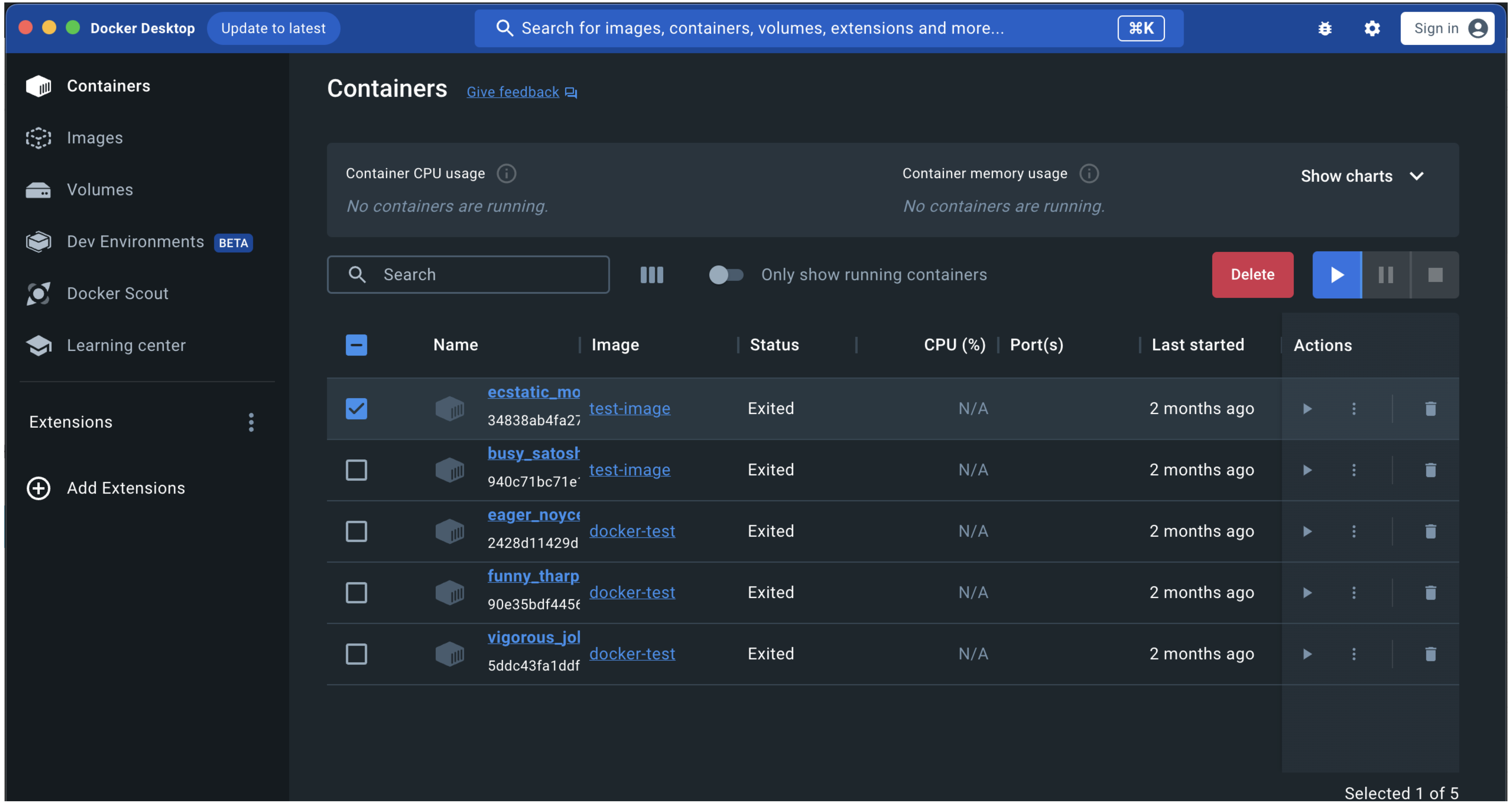


[1] Icons by icons8.com

Overview of Docker components

- Most important Docker components:
  - **Docker Desktop**
  - **Docker Engine**
    - Docker Client
    - Docker Daemon
  - **Docker Objects**
    - Docker Images
    - Docker Containers
  - **Docker Registries**

Installing Docker via Docker Desktop



Containers

Container CPU usage
No containers are running.

Container memory usage
No containers are running.

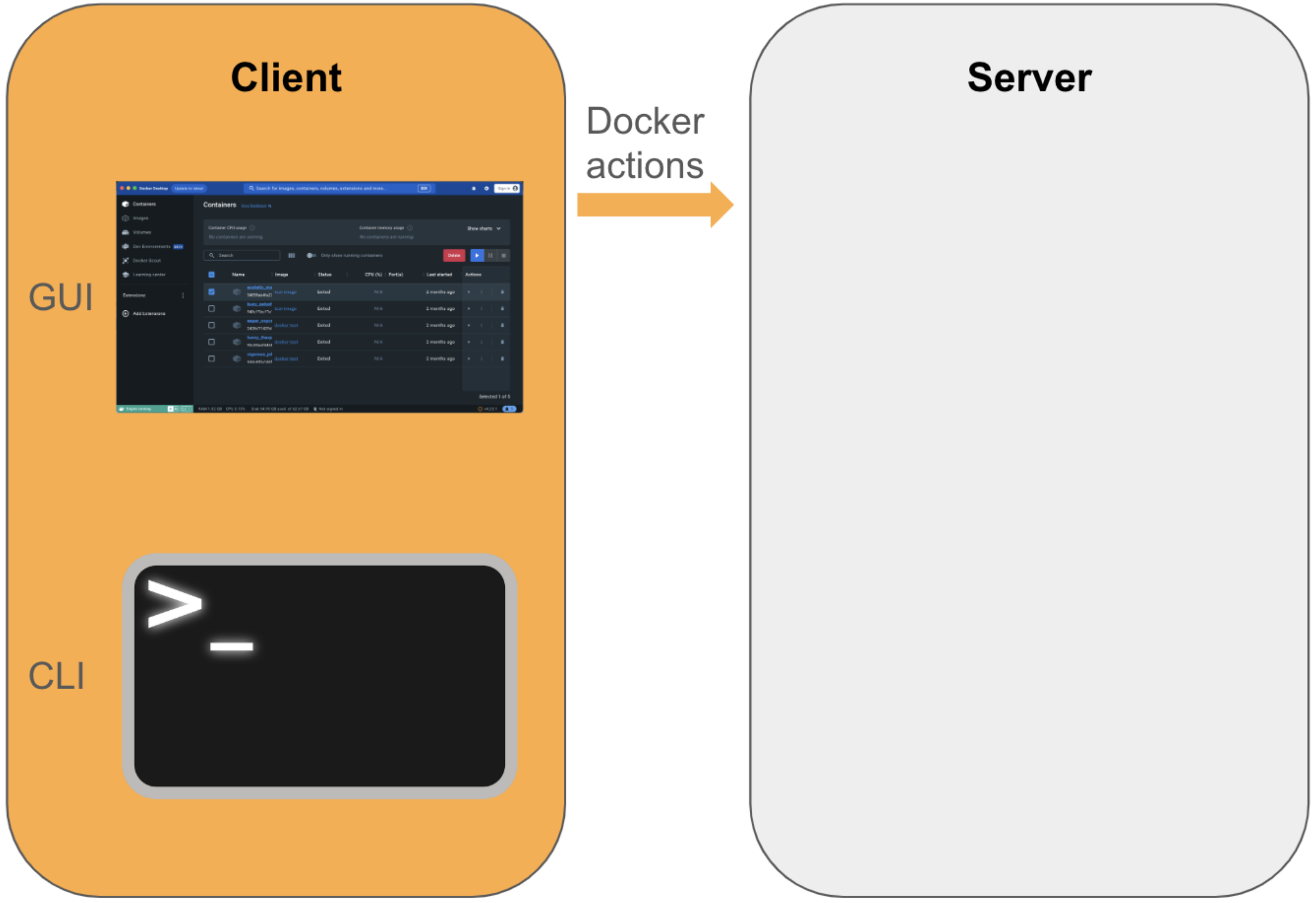
	Name	Image	Status	CPU (%)	Port(s)	Last started	Actions
✓	ecstatic_mo 34838ab4fa27	test-image	Exited	N/A		2 months ago	
	busy_satosh 940c71bc71e	test-image	Exited	N/A		2 months ago	
	eager_noyce 2428d11429d	docker-test	Exited	N/A		2 months ago	
	funny_tharp 90e35bdf4456	docker-test	Exited	N/A		2 months ago	
	vigorous_jol 5ddc43fa1ddf	docker-test	Exited	N/A		2 months ago	

Selected 1 of 5

[1] Screenshot from Docker Desktop Mac application

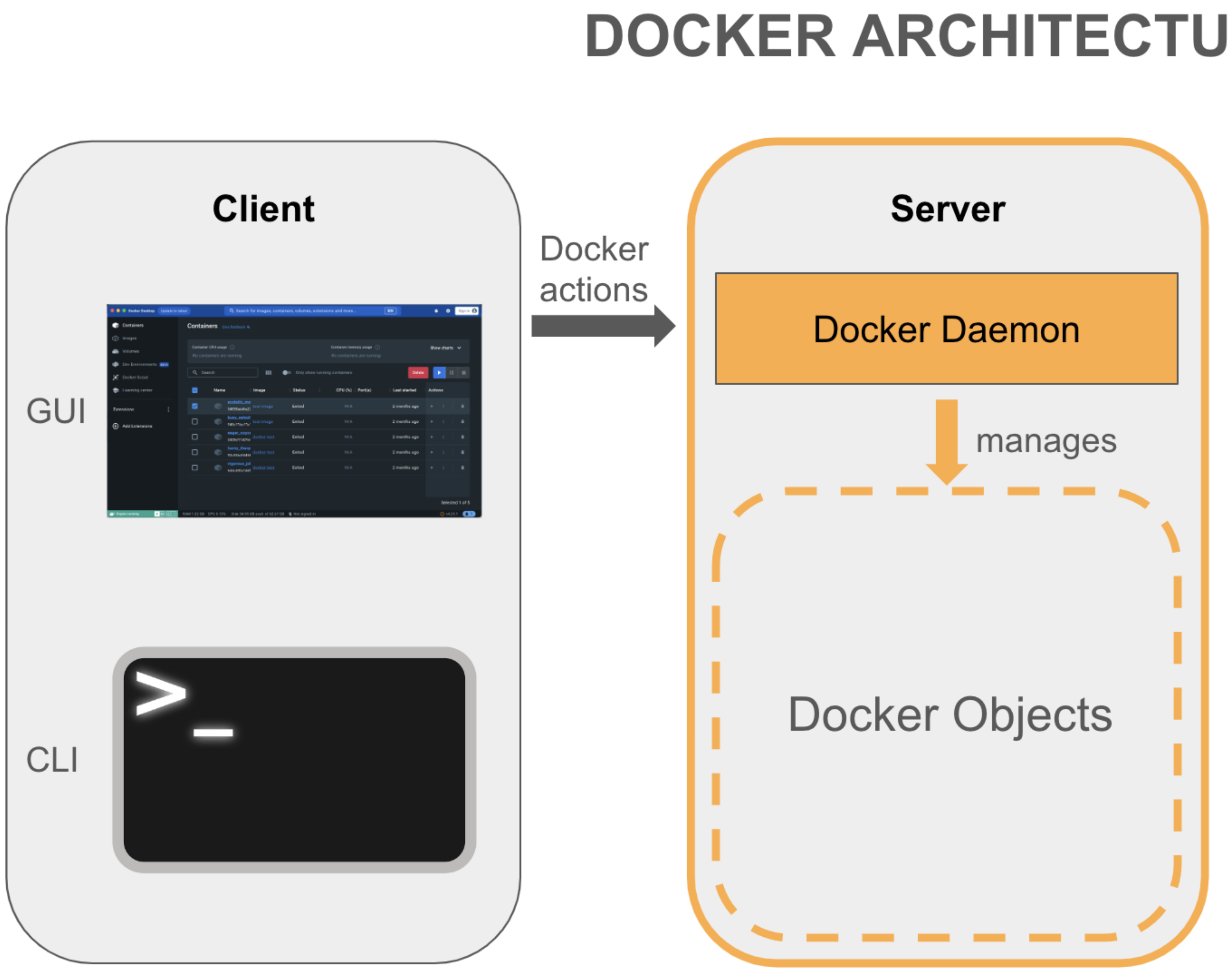
Client-server architecture of Docker Engine

DOCKER ARCHITECTURE



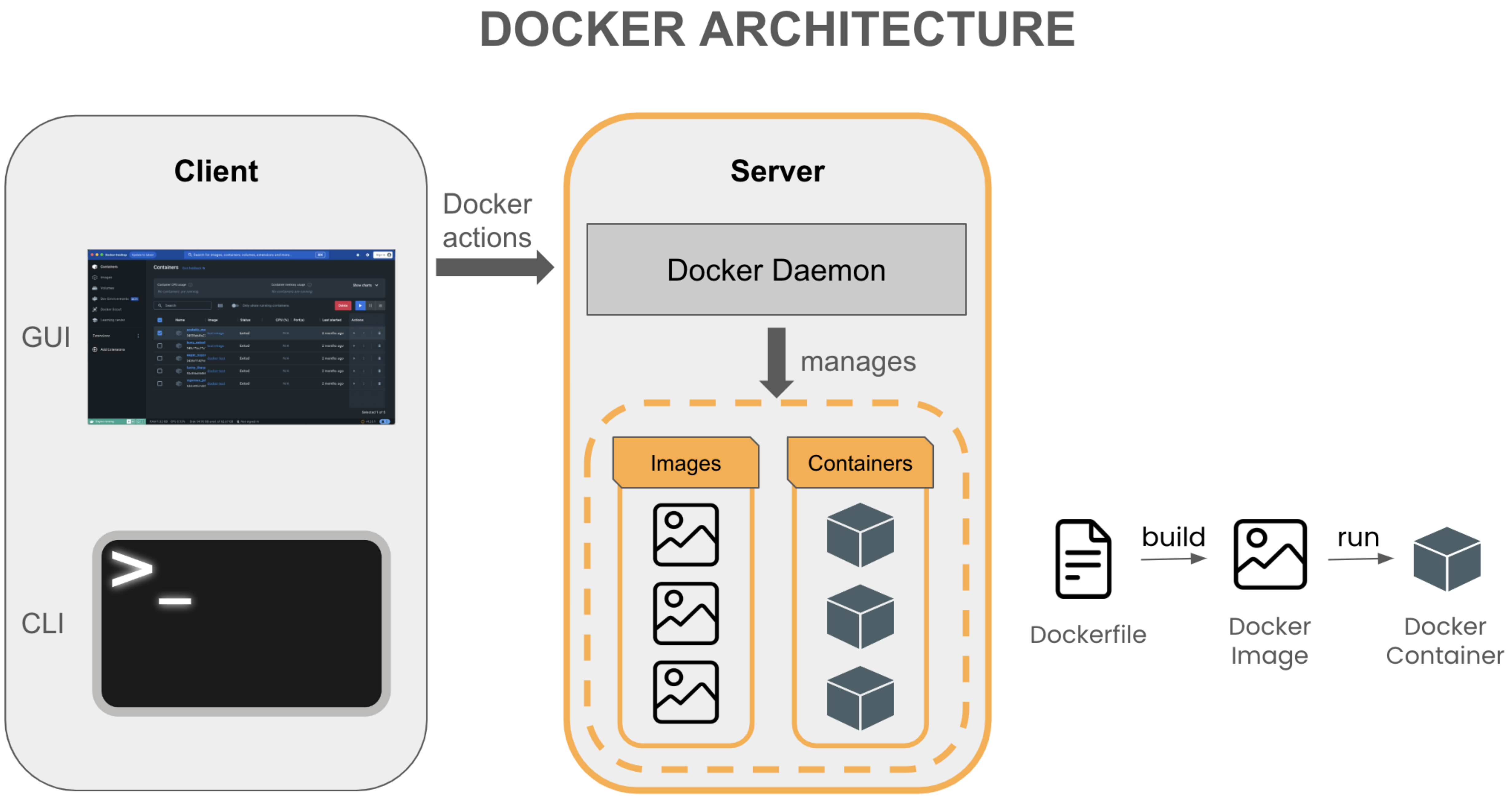
[1] Icons by icons8.com

Client-server architecture of Docker Engine



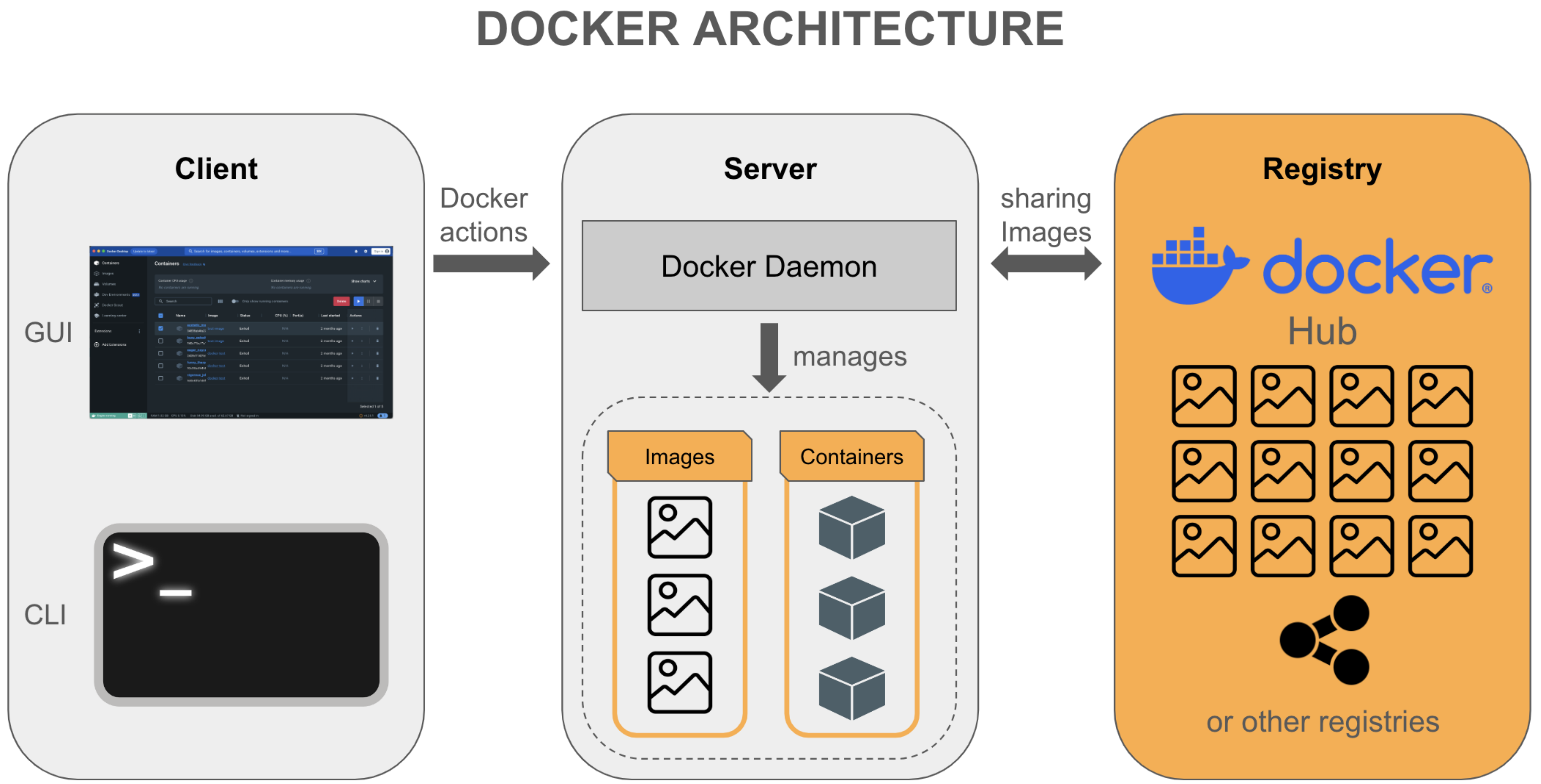
[1] Icons by icons8.com

Overview of Docker objects



[1] Icons by icons8.com

Sharing containers via registries



[1] Icons by icons8.com

Let's practice!

CONTAINERIZATION AND VIRTUALIZATION CONCEPTS

Container orchestration

CONTAINERIZATION AND VIRTUALIZATION CONCEPTS

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Definition of container orchestration

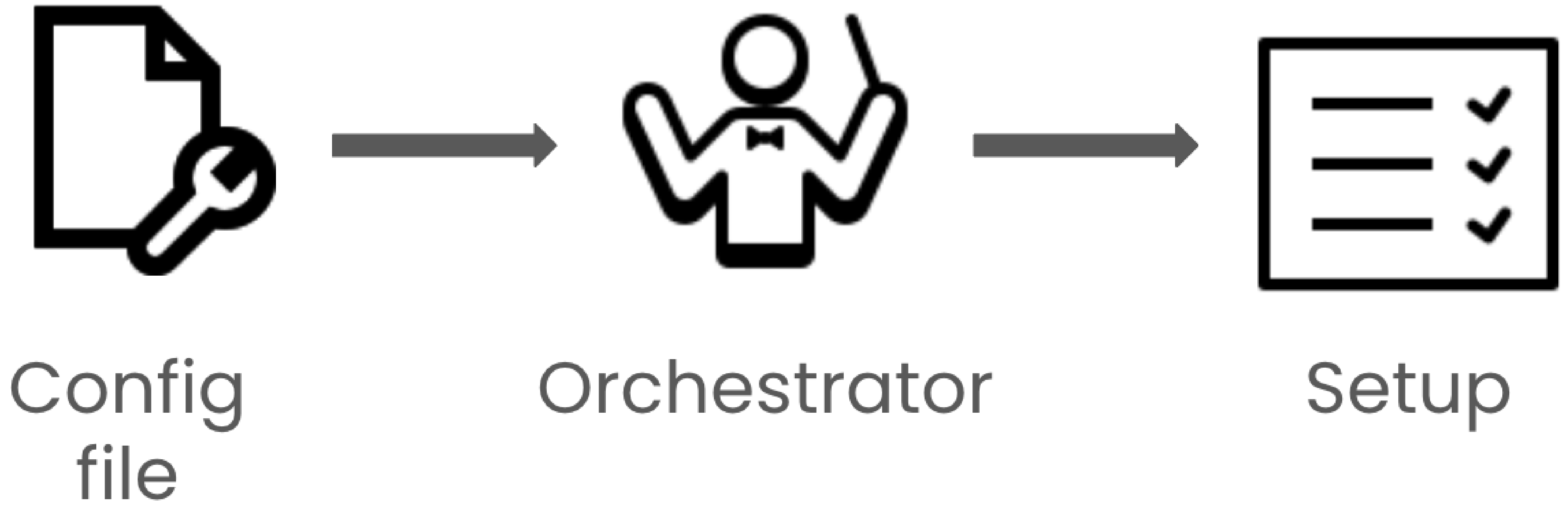
- **Orchestration:**
  - The automated management of multiple components
- **Orchestrator:**
  - The tool used for orchestration
- **Container Orchestration:**
  - Orchestration of containers

Purpose of container orchestration

- Simplifies management of many containers
- Ensuring that multiple containers interact **effectively and efficiently**

Declarative programming in container orchestration

- Declarative programming:
  - Defining the desired output instead of describing the steps to reach it



[1] Icons by Icons8.com

Benefits of container orchestration

- Easy **scaling** of containers
  - Horizontal scaling: Adding/Removing containers
  - Vertical scaling: In-/Decreasing computing resources of specific containers
- **Automation** of operations
  - Time savings
  - Improved developer productivity
  - Cost savings
- Better **performance** of application

Applications of container orchestration

- Microservices architecture
- Application scaling
- Automation of pipelines

Container orchestration tools

Swarm mode

HashiCorp Nomad

OpenShift

kubernetes

[1] Logos by Docker Inc., Red Hat Inc., HashiCorp Inc., and The Linux Foundation

Let's practice!

CONTAINERIZATION AND VIRTUALIZATION CONCEPTS

Container orchestration with Kubernetes

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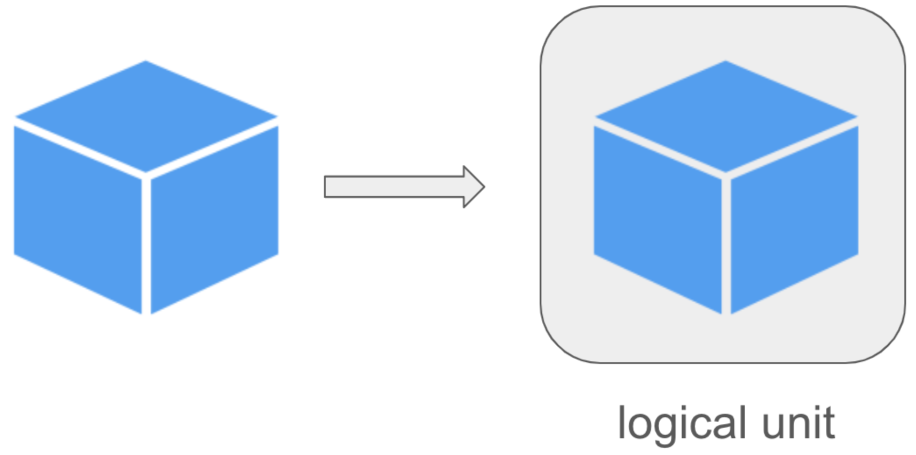
Introducing Kubernetes

- Abbreviation: K8s
- Developed by Google, open-sourced in 2014
- 96% of organizations use/evaluate using Kubernetes

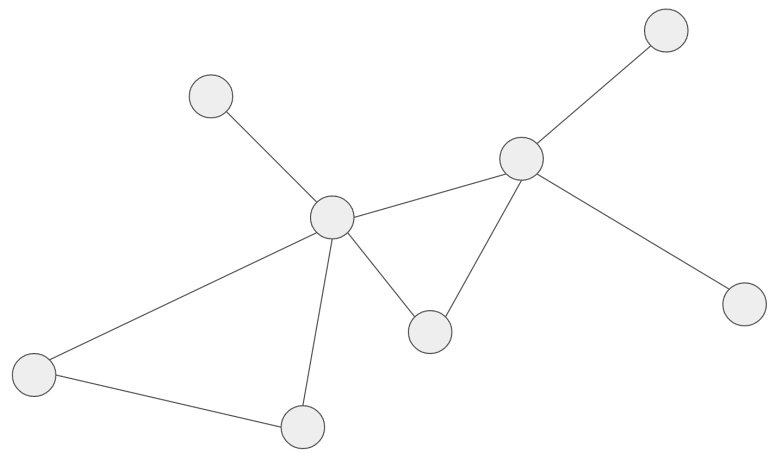
[1] Cloud Native Computing Foundation (CNCF) Annual Survey in 2022 [2] Logo by The Linux Foundation

Introducing Kubernetes

- Grouping containers into logical units



- Distributed system

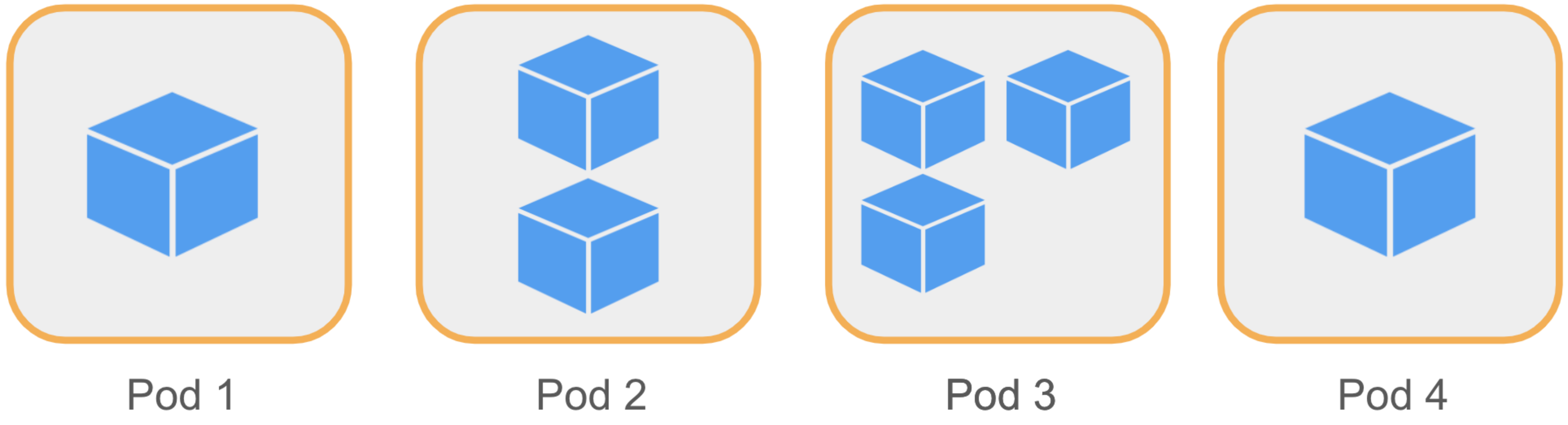


[1] Icons by Icons8.com

Overview of Kubernetes components

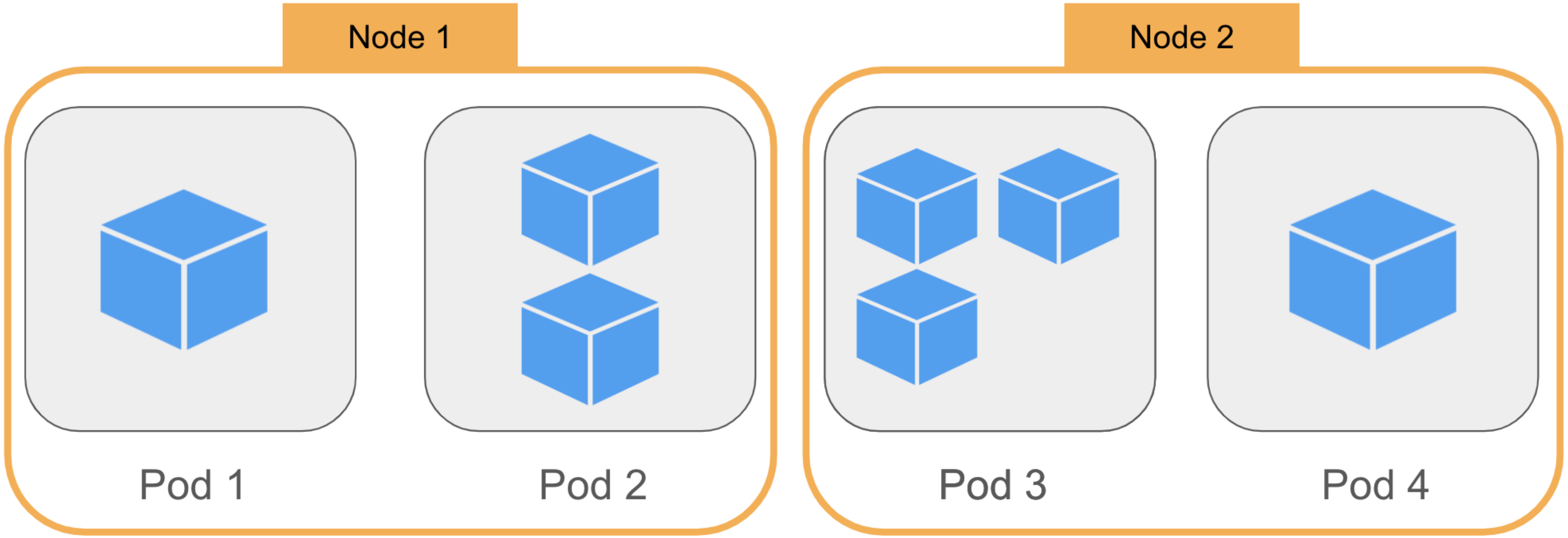
- Most important Kubernetes components:
  - Pods
  - Nodes
  - Control Plane
  - Cluster

Pods as smallest deployable unit



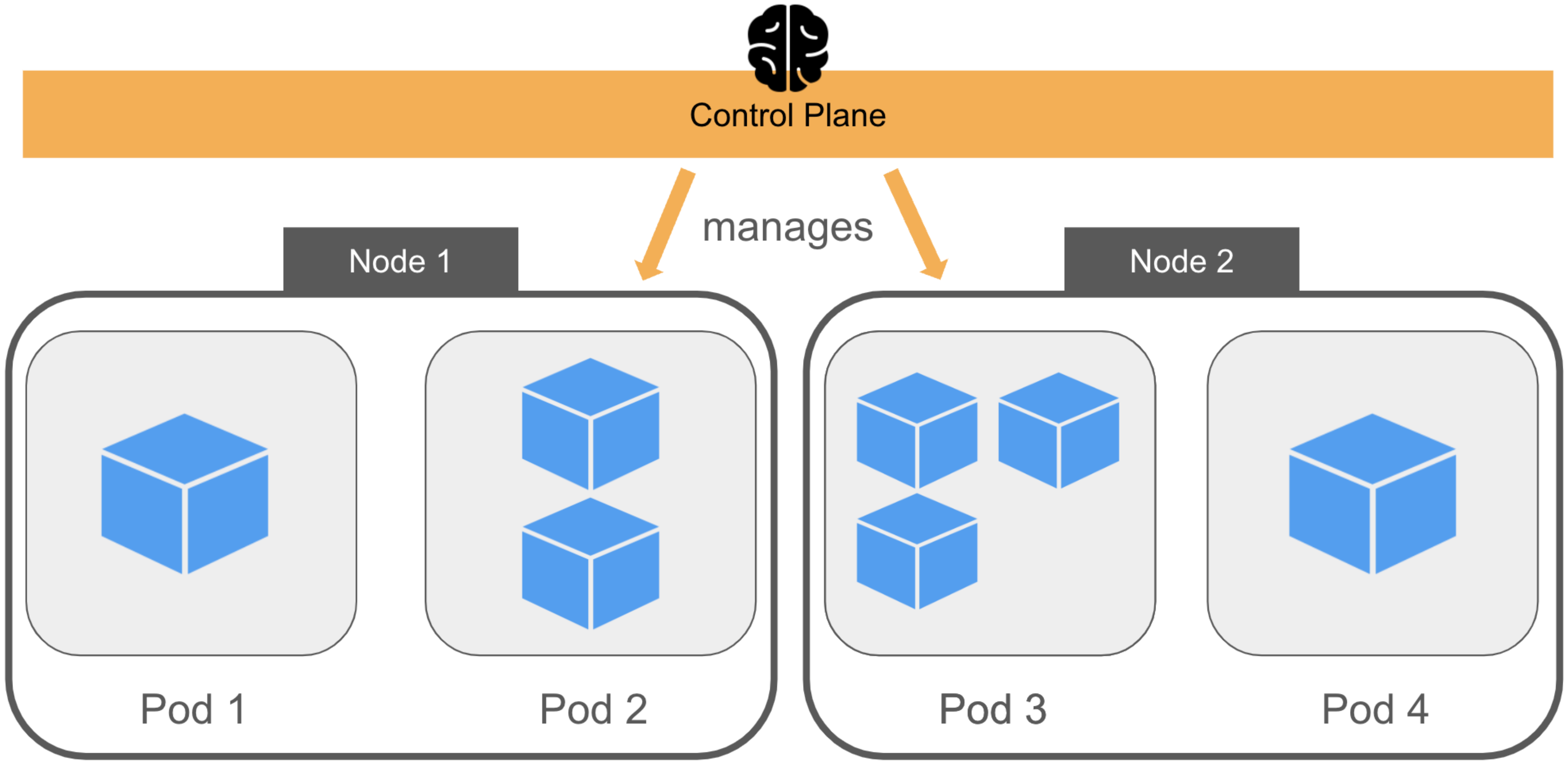
[1] Icons by Icons8.com

Nodes as smallest hardware unit



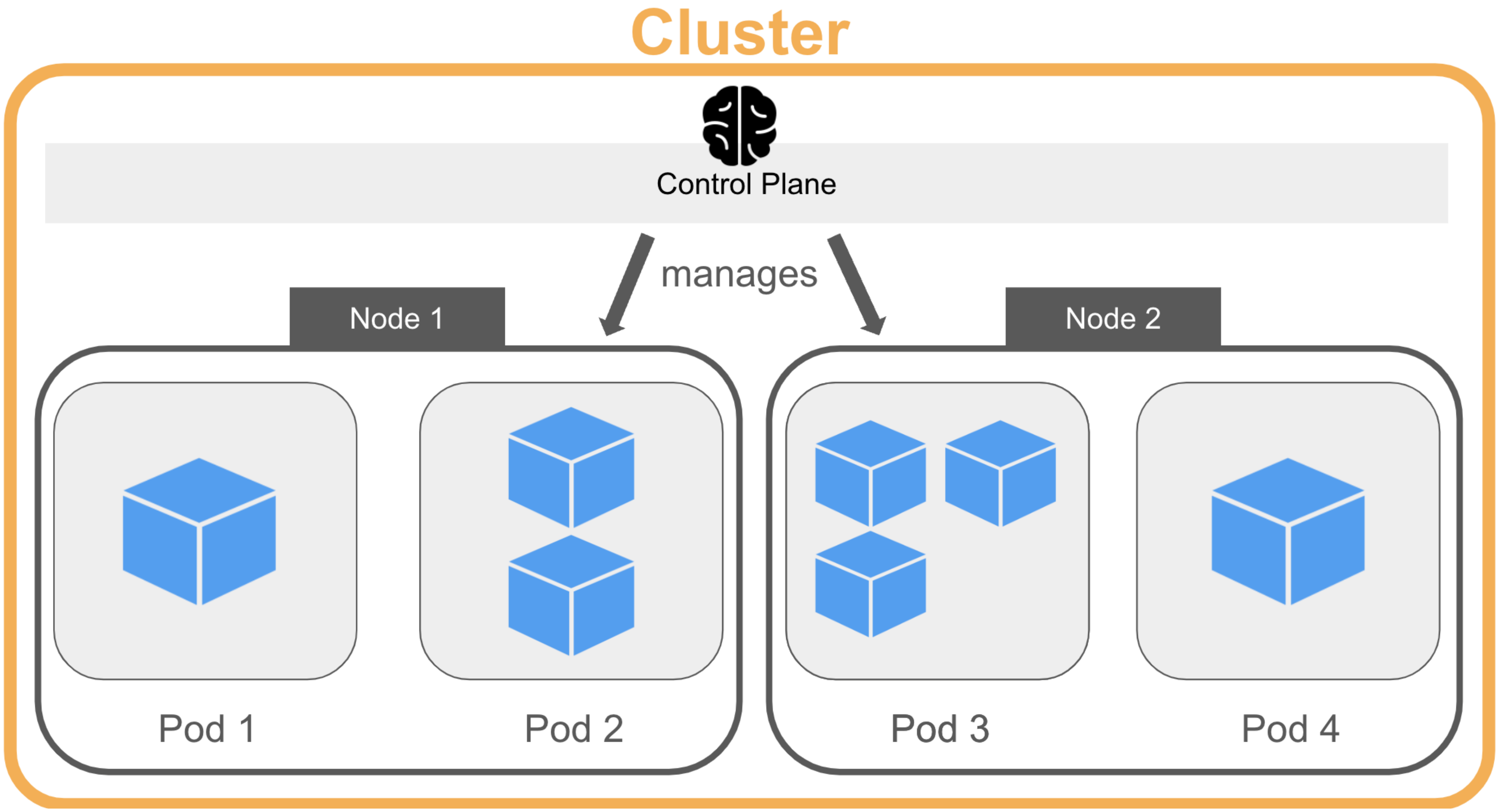
[1] Icons by Icons8.com

Node management via control plane



[1] Icons by Icons8.com

Grouping nodes in a cluster



[1] Icons by Icons8.com

Docker and Kubernetes

- Docker: Dealing with **one or few containers**

- Kubernetes: Dealing with **many containers**

Let's practice!

CONTAINERIZATION AND VIRTUALIZATION CONCEPTS

Reading Dockerfiles and running containers

CONTAINERIZATION AND VIRTUALIZATION CONCEPTS

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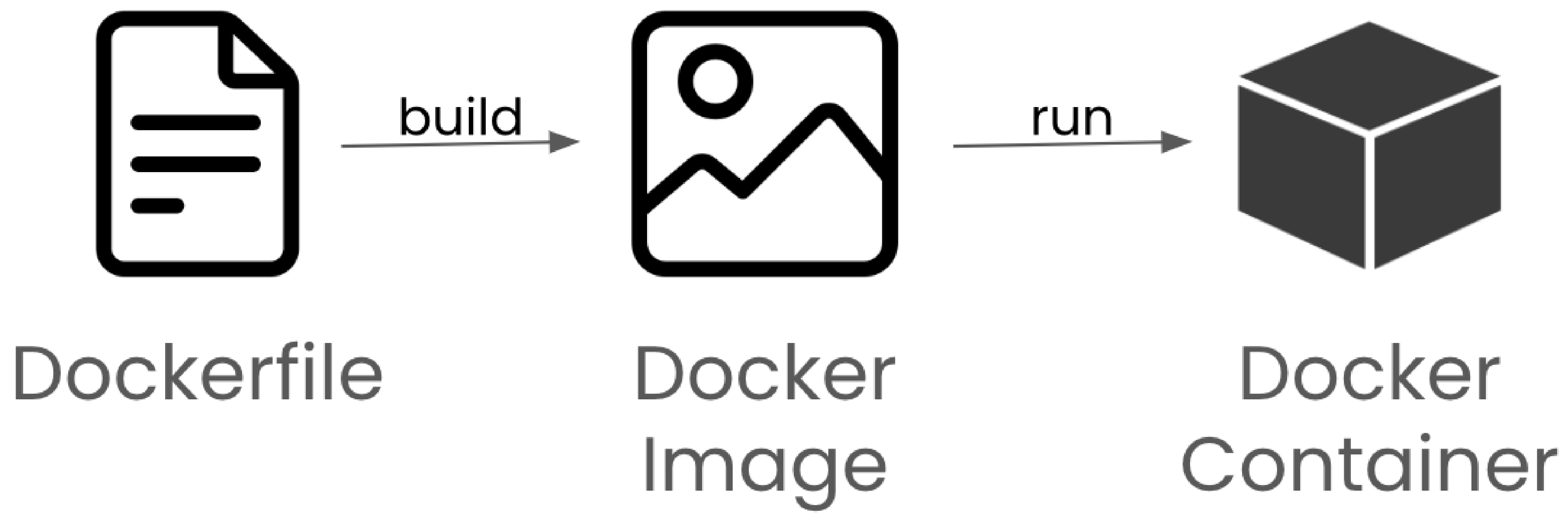
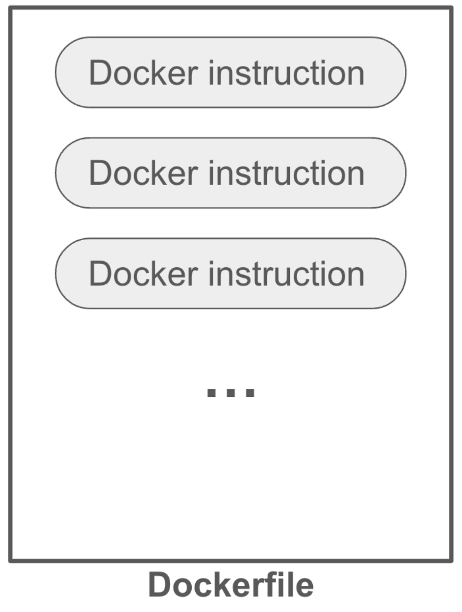
Recap of Docker terms



Docker instructions vs. Docker commands

- Docker instructions detail how to build a Docker image



- Docker commands: Commands via Command Line Interface (CLI)

```
>docker command
```

Format of a Dockerfile

comment

```
# Define the image on which to build
FROM python:3.10

...
```

Format of a Dockerfile

```
# Define the image on which to build
FROM python:3.10

...
```

Docker instruction

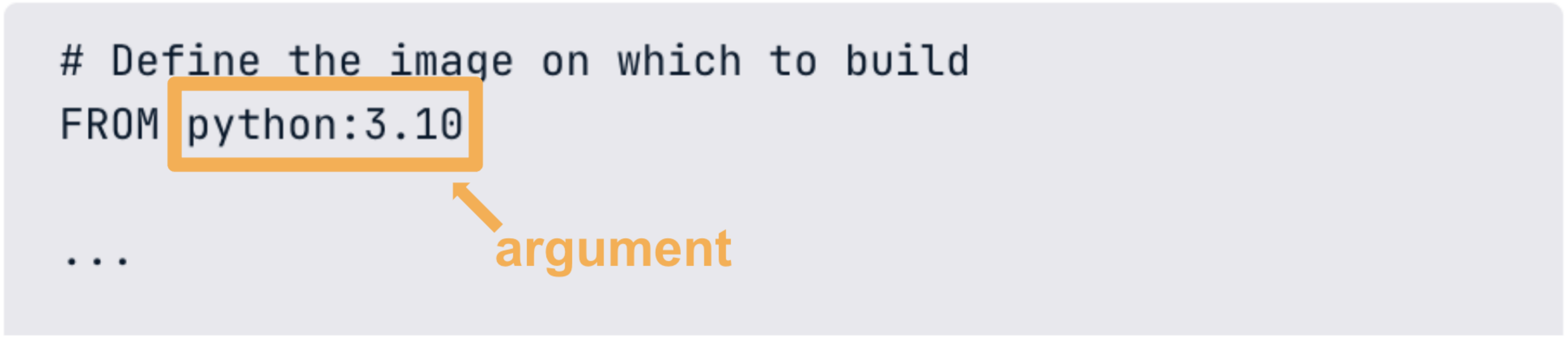
Format of a Dockerfile

```
# Define the image on which to build
FROM python:3.10

...
```

COMMAND

Format of a Dockerfile



```
# Define the image on which to build
FROM python:3.10

...
```

Sequential order in Dockerfiles

- Execution in sequential order
- Start of a Dockerfile:
  - Metadata
  - Comments
  - Arguments
  - `FROM` instruction

Overview of Docker instructions

- Important Docker instructions
  - `FROM`
  - `COPY`
  - `RUN`
  - `ENTRYPOINT`

FROM instruction

- Specifies an existing Docker image
- Defines the image we are building on
  - "Starting point"

Syntax:

```
FROM <name_of_image>
```

Example:

```
# Define the image on which to build
FROM python:3.10
```

COPY instruction

- Copies files or directories
  - From source (<source>) to destination (<destination>)
  - Files that are needed in following Docker instructions

Syntax:

```
COPY <source> <destination>
```

Example:

```
# Copy files/folders to the main folder of the container
COPY . .
```

RUN instruction

- Runs a command within a container
  - Can be any command that could be run in a CLI

Syntax:

```
RUN <command>
```

Example:

```
# Install the application's dependencies
RUN pip install -r requirements.txt
```

ENTRYPOINT instruction

- Defines the container's default behavior
  - Specifies command to run at initiation
  - The primary purpose of the container

Syntax:

```
ENTRYPOINT ["command", "argument"]
```

Example:

```
# Run the script when the container starts
ENTRYPOINT ["python", "hello_world.py"]
```

Assembling instructions to Dockerfile

```
# Define the image on which to build
FROM python:3.10
```

Assembling instructions to Dockerfile

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# Define the image on which to build
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# Copy files/folders to the main folder of the container
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Assembling instructions to Dockerfile

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# Copy files/folders to the main folder of the container
COPY . .

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RUN pip install -r requirements.txt

# Run the script when the container starts
ENTRYPOINT ["python", "hello_world.py"]
```

Docker build command

- Builds Docker image from a Dockerfile
    - Dockerfile needs to be located in build's context (<context>)
    - Executed as command with Docker client via CLI

Syntax:

```
docker build <context>
```

Docker run command

- Creates and runs Docker container from Docker image
  - Docker image needs to be specified as argument (<name_of_image>)
  - Executed as command with Docker client via CLI

Syntax:

```
docker run <name_of_image>
```

Let's practice!

CONTAINERIZATION AND VIRTUALIZATION CONCEPTS

Wrap-up

CONTAINERIZATION AND VIRTUALIZATION CONCEPTS

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Recap of course goals

- Chapter 1
  - Define virtualization
  - Define containerization
  - Comparing containerization and virtualization

- Chapter 2
  - Explain containerization with Docker
  - Define container orchestration
  - Explain container orchestration with Kubernetes
  - Hands-on with Docker

Recap: Virtualization vs. containerization

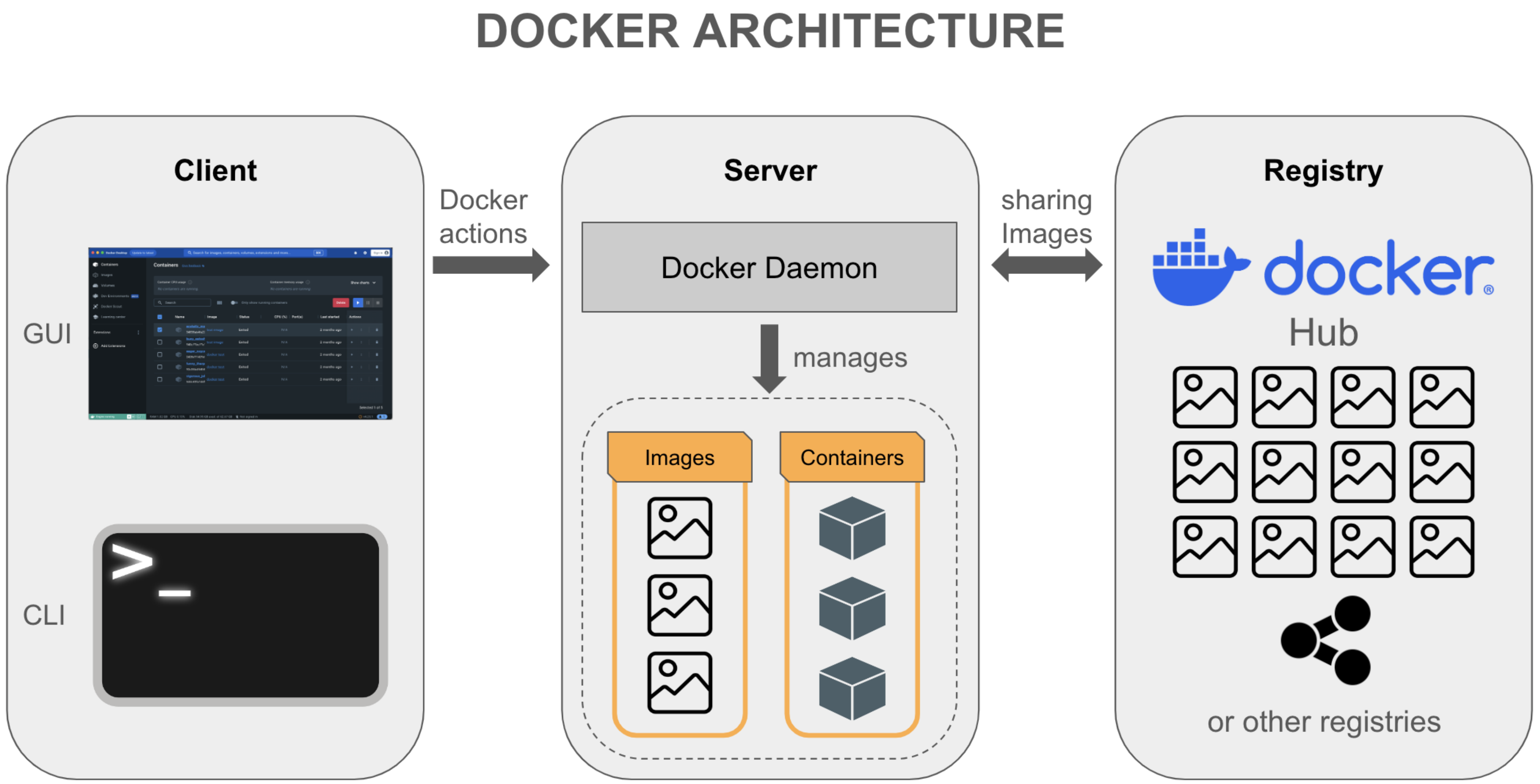
Virtualization

- Creates a virtual version of a computing resource
- Full virtualization
- VM: Simulated computer system inside another computer

Containerization

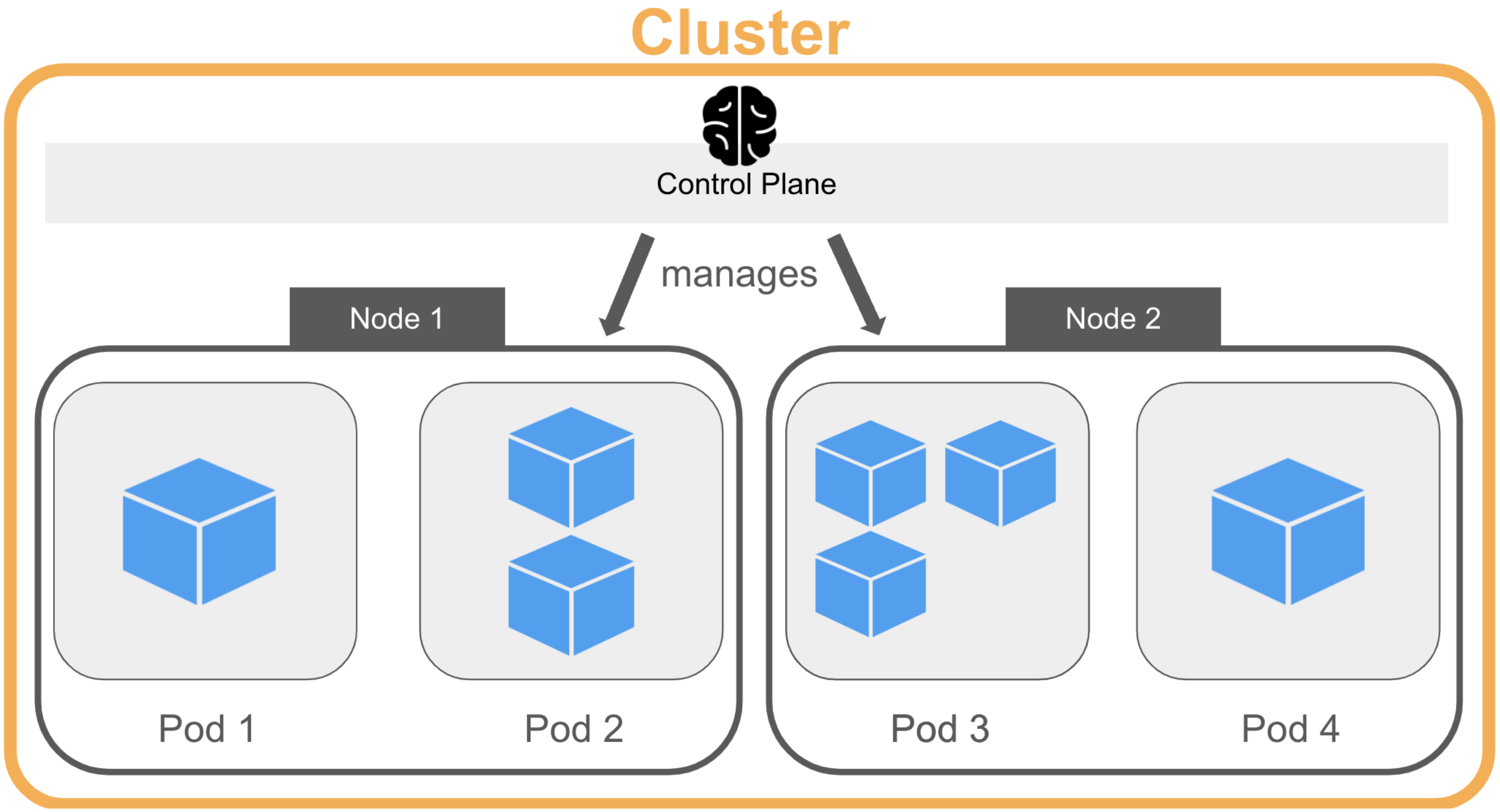
- Packages application and dependencies into isolated environment
- OS-level virtualization
- Container: Isolated application environment

Docker architecture



[1] Icons by Icons8.com

Kubernetes architecture



[1] Icons by Icons8.com

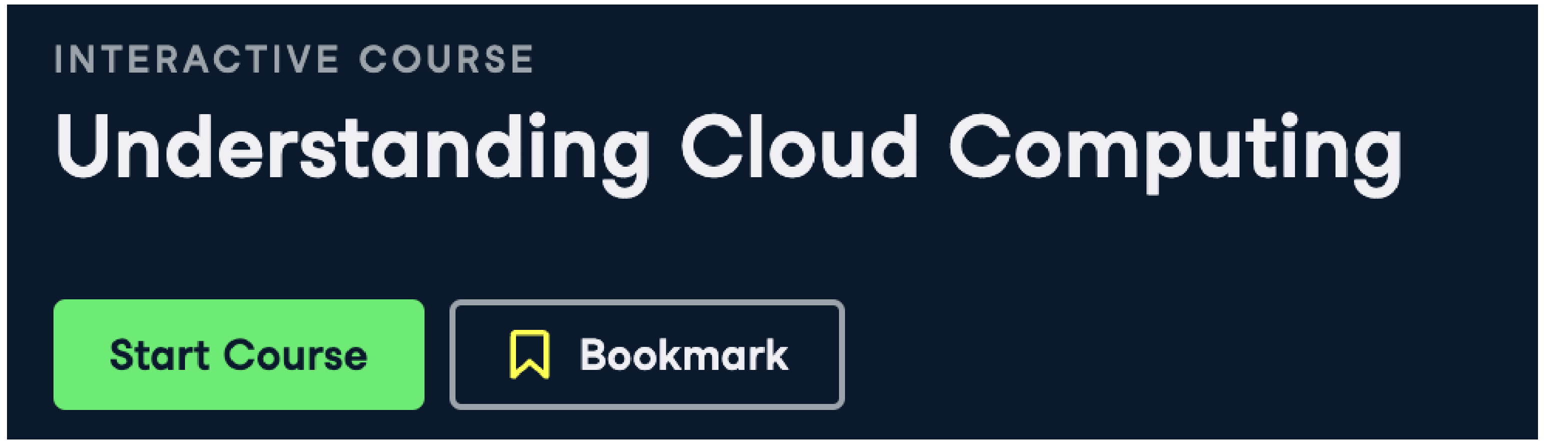
Docker instructions and commands

Docker instruction	Description
`FROM`	Defines the image to build on.
`COPY`	Copies files or directories into the container.
`RUN`	Runs a command inside the container.
`ENTRYPOINT`	Defines the default behavior of the container.

Docker command	Description
`docker build <context>`	Builds a Docker image based on Dockerfile.
`docker run <name_of_image>`	Runs a Docker container based on Docker image.

Hungry for more?

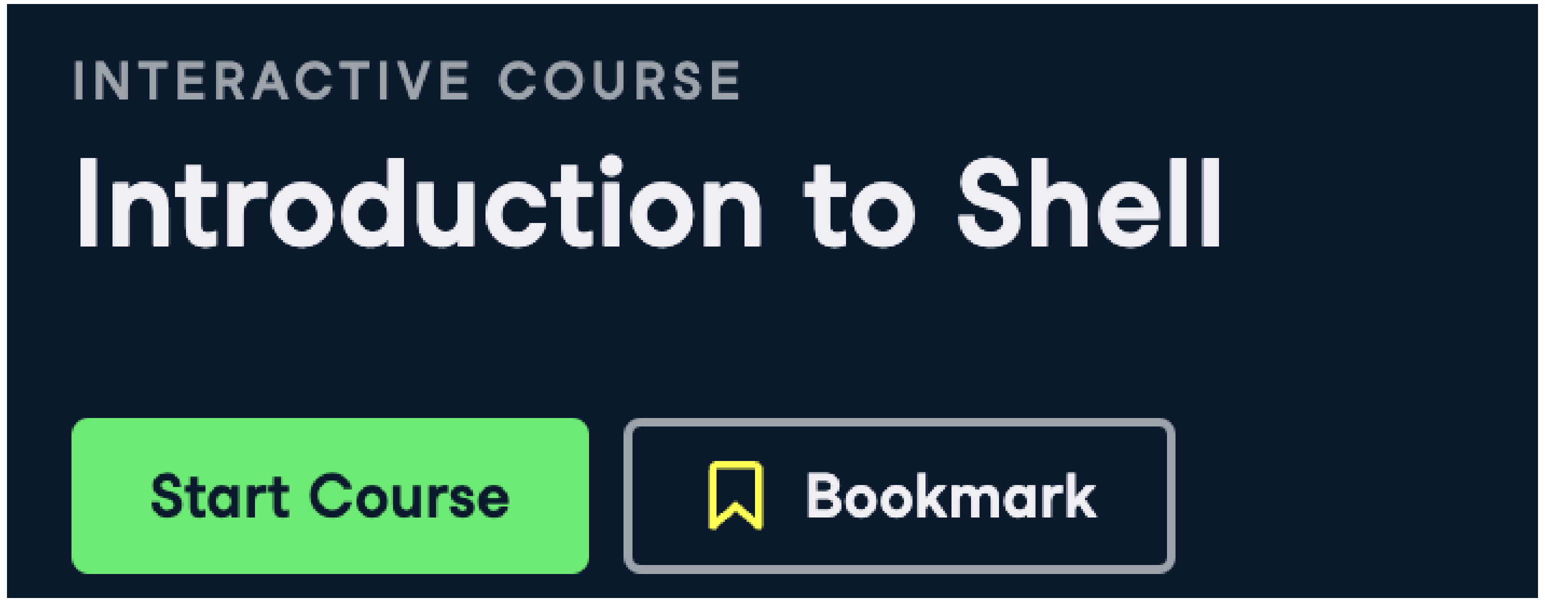
- Understanding computing in the cloud



INTERACTIVE COURSE

Understanding Cloud Computing

- Dealing with CLI



INTERACTIVE COURSE

Introduction to Shell

Hungry for more?

- **Continue learning about Docker & Kubernetes!**
  1. `DONE` Introduction to Containerization and Virtualization
  2. `UPCOMING` Introduction to Docker
  3. Intermediate Docker
  4. Introduction to Kubernetes

Congratulations!

CONTAINERIZATION AND VIRTUALIZATION CONCEPTS