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Containerization 101: Building with Docker

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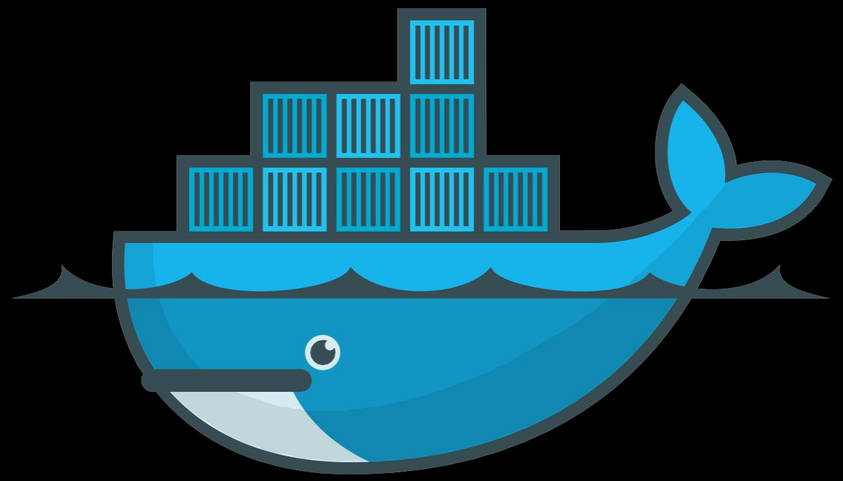
https://github.com/thealcodingclub/containerization101

What is Docker?

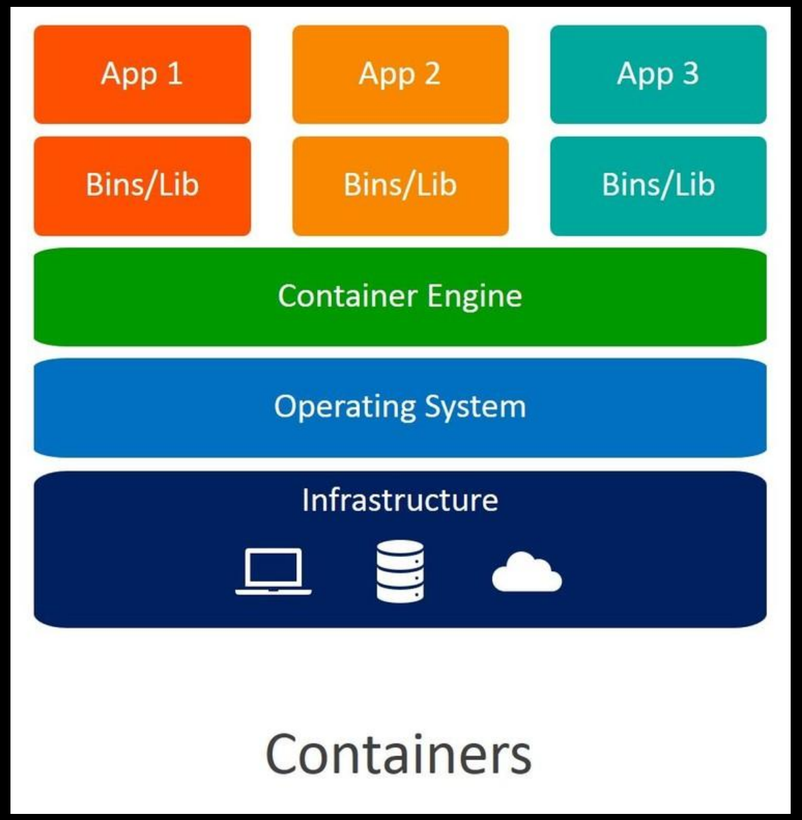
A platform for developing, shipping, and running applications consistently
Enables packaging applications with all dependencies
Solves "it works on my machine" problem Platform independent deployment

Key benefits:

- Consistency across environments
- Improved collaboration
- Rapid deployment
- Resource efficiency

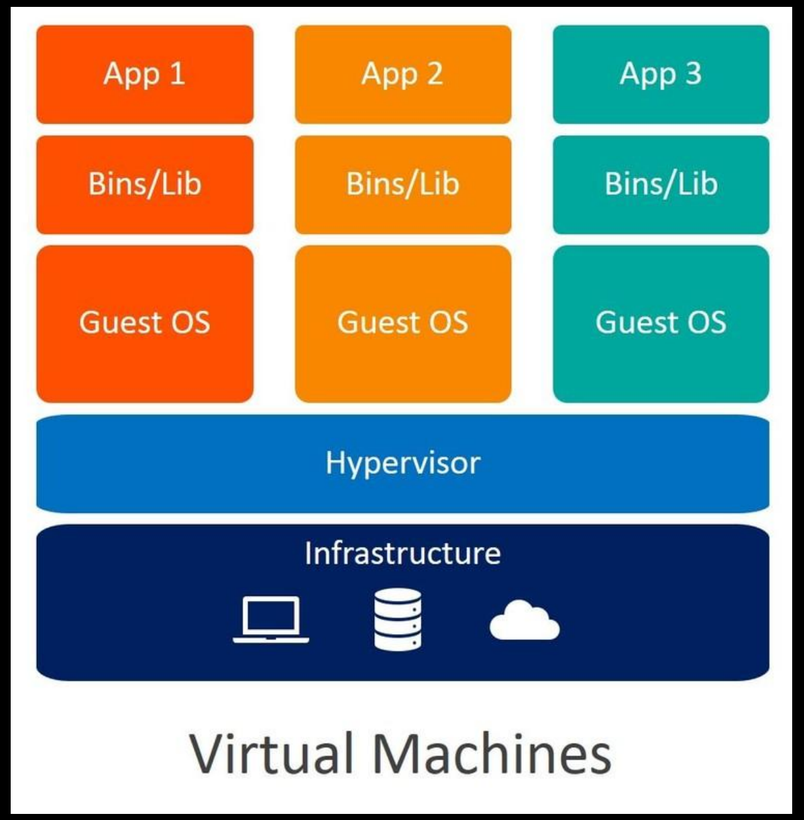


Containerization

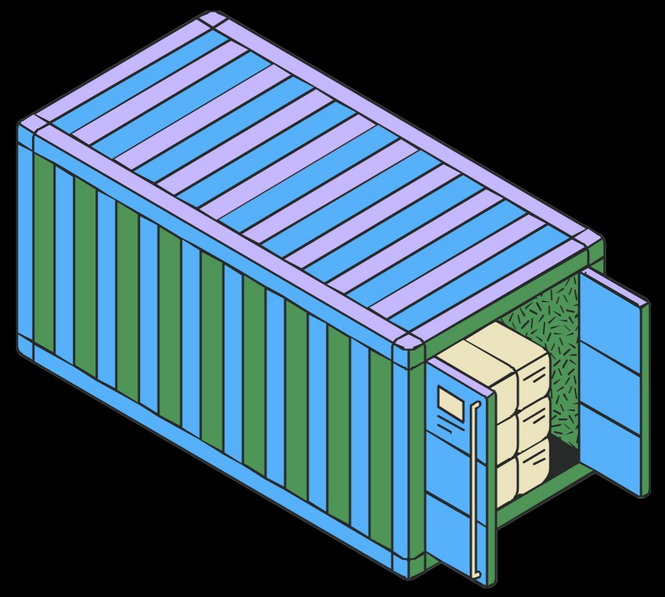


vs

Virtualization



Containerization



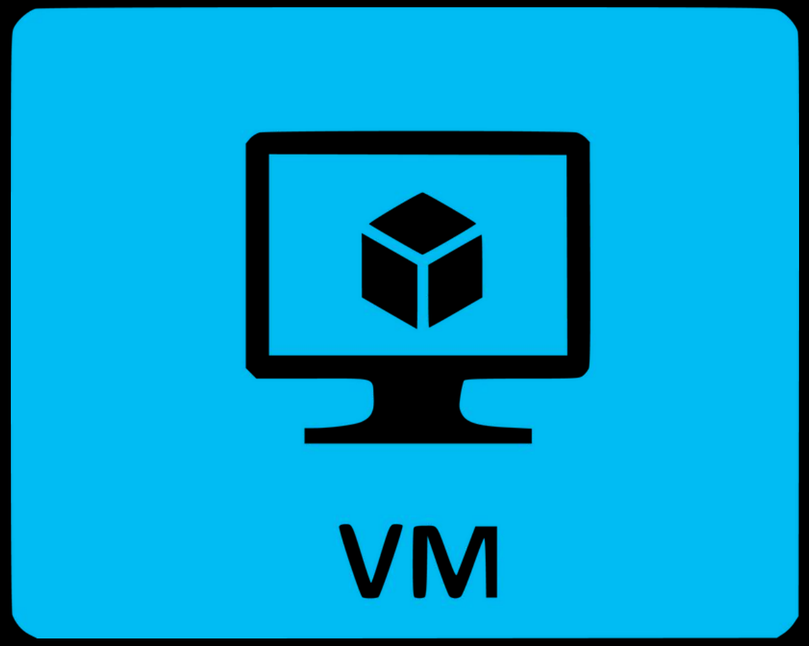
Containers:

- Share host OS kernel
- Lightweight (MBs) Seconds to start
- Less resource intensive Perfect for microservices

Virtualization

Virtual Machines:

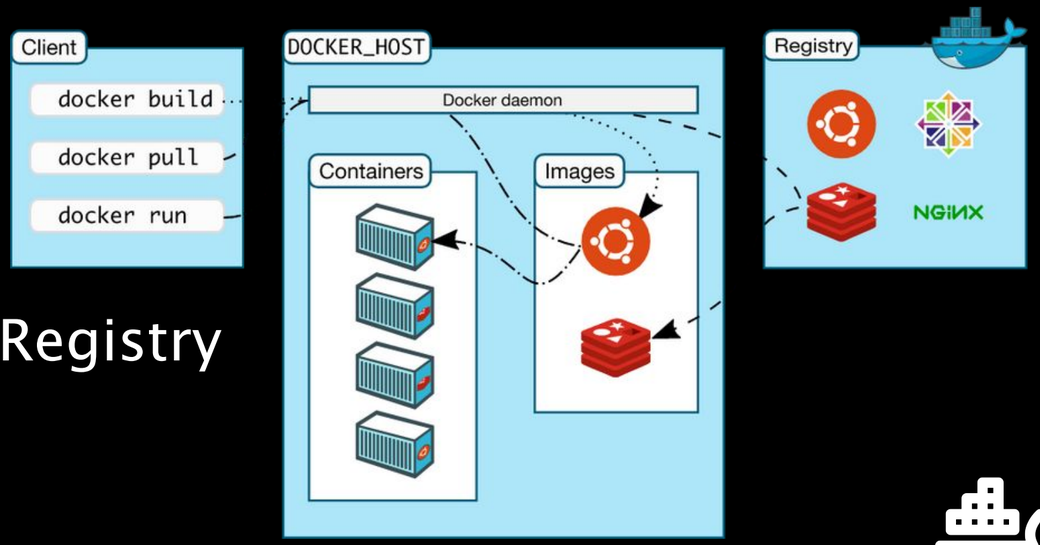
- Complete OS copy
- Heavy (GBs) Minutes to start
- More resource intensive
- Better isolation



Docker Architecture

Client-Server Architecture:

a. Docker Client: Command line interface
b. Docker Daemon: Builds, runs, and manages containers
c. Docker Registry: Stores Docker images
d. Docker Objects: Images and containers



Communication flow:

Client → REST API → Daemon Daemon ↔ Registry

Docker Installation

Windows

```
# Download Docker Desktop from docker.com
# Run installer
# Enable WSL 2
# Start Docker Desktop
```

Linux

```
sudo apt-get update
sudo apt-get install docker-ce
sudo systemctl start docker
sudo usermod -aG docker $USER
```

Verification

```
docker --version
docker run hello-world
```

First Container Demo

```
# Pull and run hello-world
docker run hello-world

# Run nginx server
docker run -d -p 80:80 nginx

# Access localhost in browser
```

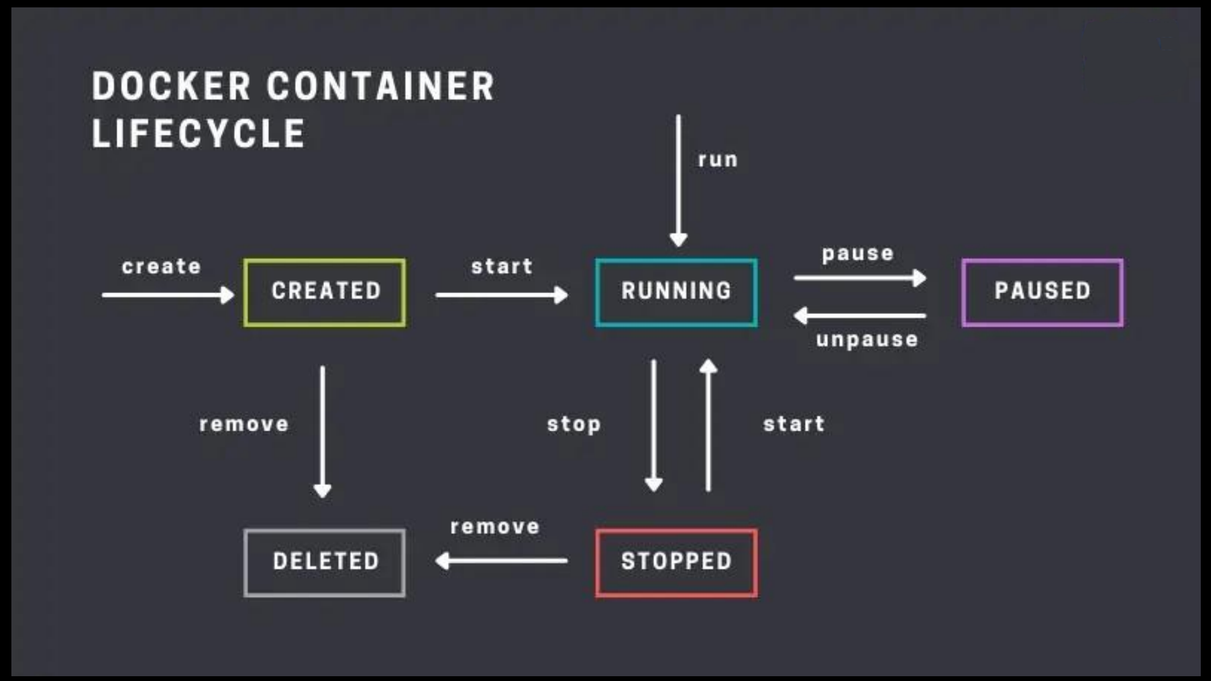
1. Checks for local image
2. Pulls from Docker Hub
3. Creates container
4. Runs container

Basic Commands

```
# List containers
docker ps
docker ps -a

# List images
docker images

# Pull image
docker pull ubuntu:latest

# Run container
docker run -it ubuntu bash

# Remove container
docker rm container_id

# Remove image
docker rmi image_id
```

Container Lifecycle

1. Created: docker create
2. Running: docker start/run
3. Paused: docker pause/unpause
4. Stopped: docker stop
5. Deleted: docker rm



Dockerfile Basics

```
# Base image
FROM node:14-alpine

# Set working directory
WORKDIR /app

# Copy package files
COPY package*.json ./

# Install dependencies
RUN npm install

# Copy application code
COPY . .

# Expose port
EXPOSE 3000

# Start command
CMD ["npm", "start"]
```

Dockerfile Basics

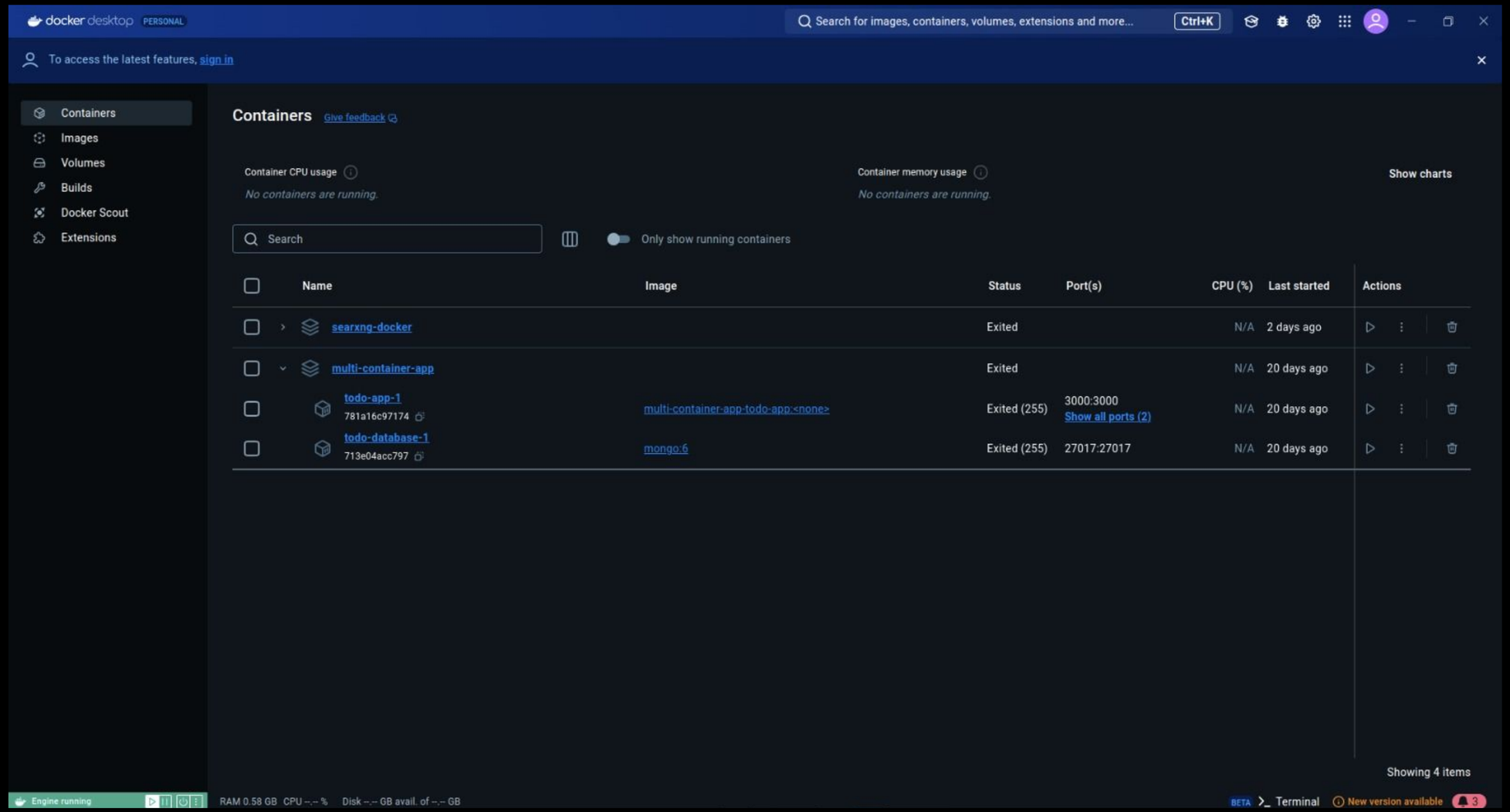
Best Practices:

- ✓ Use specific base image tags
- ✓ Minimize layers
- ✓ Use .dockerignore
- ✓ Security considerations

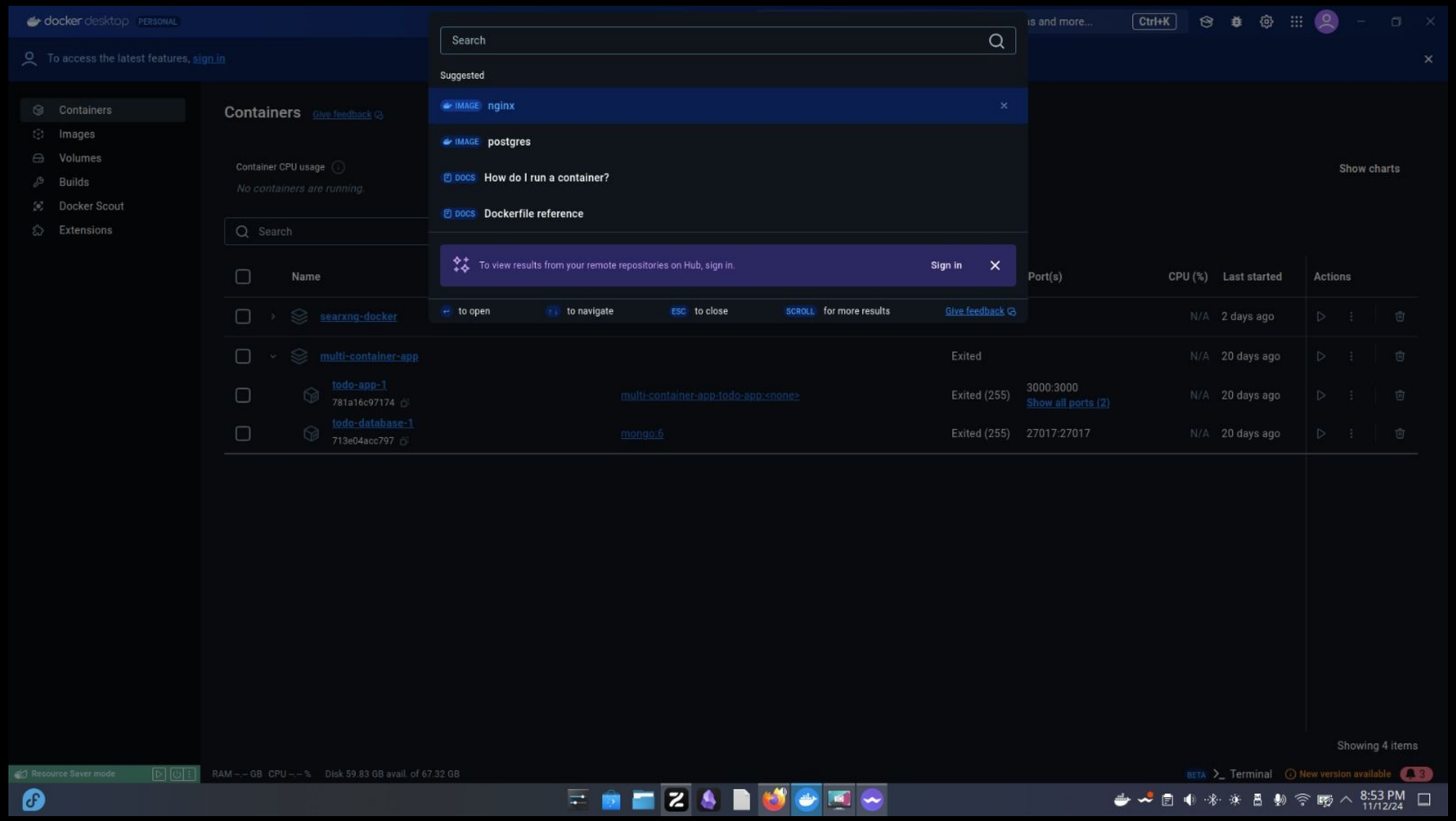
Building Images

```
# Build image
docker build -t myapp:1.0 .

# Tag image
docker tag myapp:1.0 username/myapp:1.0

# Push to registry
docker push username/myapp:1.0

# Build with different Dockerfile
docker build -f Dockerfile.prod -t myapp:prod .
```

Docker Desktop



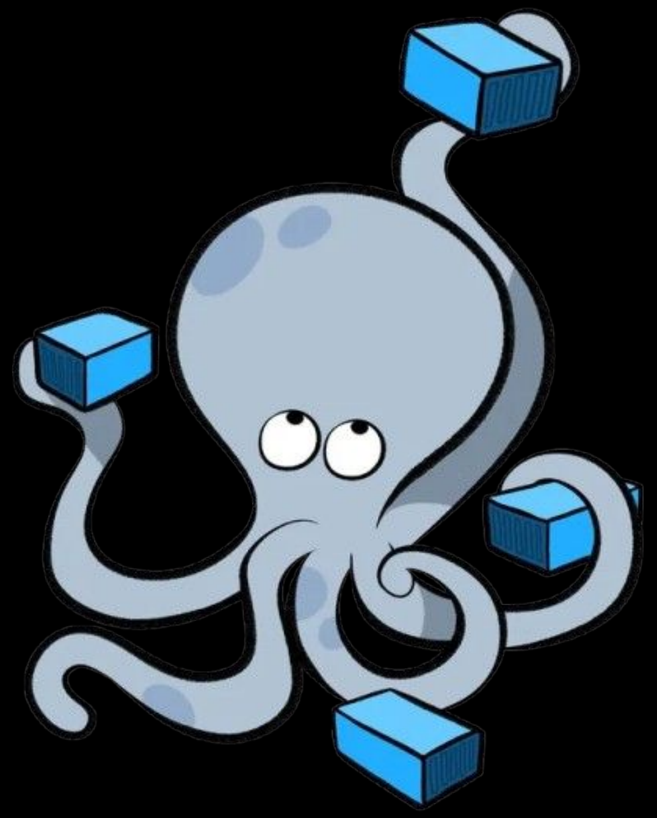
Docker Hub


docker desktop PERSONAL
To access the latest features, sign in
Containers
Images
Volumes
Builds
Docker Scout
Extensions
Containers
Give feedback
Container CPU usage
No containers are running.
Search
Suggested
IMAGE nginx
IMAGE postgres
DOCS How do I run a container?
DOCS Dockerfile reference
To view results from your remote repositories on Hub, sign in.
Sign in
to open
to navigate
ESC to close
SCROLL for more results
Give feedback
Ctrl+K
Show charts
Name
Port(s)
CPU (%)
Last started
Actions
searxng-docker
N/A
2 days ago
multi-container-app
Exited
N/A
20 days ago
todo-app-1
781a16c97174
multi-container-app-todo-app:<none>
Exited (255)
3000:3000
Show all ports (2)
N/A
20 days ago
todo-database-1
713e04acc797
mongo:6
Exited (255)
27017:27017
N/A
20 days ago
Showing 4 items
Resource Saver mode
RAM –.– GB CPU –.– %
Disk 59.83 GB avail. of 67.32 GB
Terminal
New version available
8:53 PM
11/12/24

Docker Compose

Purpose:

- Define multi-container applications
- Single source of truth for app configuration Simplified deployment



Docker Compose

Example docker-compose.yml

```yaml
version: '3.8'
services:
     web:
        build: .
        ports:
             - "3000:3000"
        environment:
             - DB_HOST=db
         depends_on:
              - db
db:
    image: mongo:latest
    volumes:
          - db-data:/data/db
volumes:
    db-data:
```

Docker Compose Commands

```
# Start services
docker-compose up -d

# Stop services
docker-compose down

# View status
docker-compose ps

# View logs
docker-compose logs -f

# Scale service
docker-compose up -d --scale web=3

# Rebuild services
docker-compose build
```

Exercise one

“Hello World” web application

1. Create project

```
mkdir docker-exercise
cd docker-exercise
```

2. Create app.js

```
const express = require('express');
const app = express();
const port = 3000;

app.get('/', (req, res) => {
res.send('Hello from Docker!');
});

app.listen(port, () => {
console.log(`App running on http://localhost:${port}`);
});
```

3. Create package.json

```
{
  "name": "docker-exercise",
  "version": "1.0.0",
  "main": "app.js",

  "dependencies": {
  "express": "^4.17.1"
  },

  "scripts": {
     "start": "node app.js"
   }
}
```

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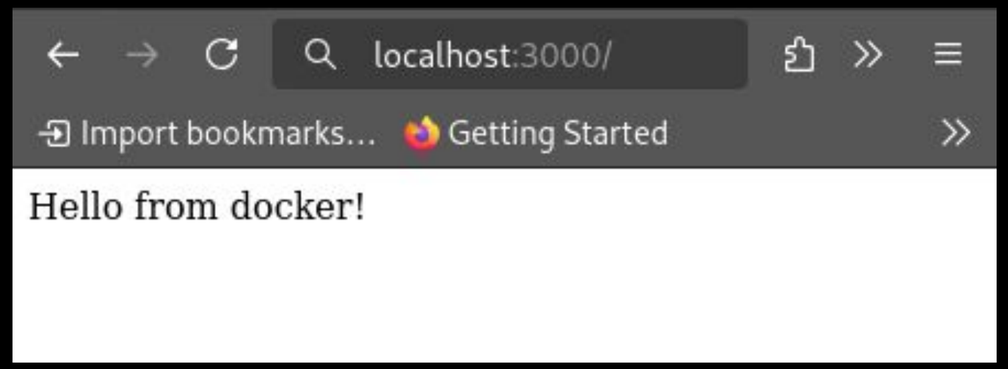
4. Create Dockerfile

```
FROM node:14-alpine
WORKDIR /app
COPY package*.json ./
RUN npm install
COPY . .
EXPOSE 3000
CMD ["npm", "start"]
```

5. Create Dockerfile

```
docker build -t hello-docker .
docker run -p 3000:3000 hello-docker
```

6. Test: Visit http://localhost:3000



Exercise two
Multi-container application

Objective: Create a Node.js application with Redis counter using Docker Compose

1. Update app.js

```
const express = require('express');
const Redis = require('redis');
const app = express();
const port = 3000;

const redis = Redis.createClient({
host: 'redis', // service name from docker-compose
port: 6379
});
```

2. Update package.json

```
{
   "dependencies": {
   "express": "^4.17.1",
   "redis": "^3.1.2"
  }
}
```

3. Create docker-compose.yml

```yaml
version: '3.8'

services:
  web:
    build: .
    ports:
      - "3000:3000"
    depends_on:
      - redis
redis:
    image: redis:alpine
```

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4. Build and run

```
docker-compose up --build
```

5. Build and run

- Visit http://localhost:3000 multiple times to see counter increase
- Try stopping and starting the containers to see data persistence