

## a) Docker Fundamentals

**What is a Docker container, and how is it different from a virtual machine (VM)?**

Docker container is a lightweight, standalone package that includes everything needed to run an application (code, runtime, libraries). It uses the host's OS kernel, making it more resource-efficient compared to VMs, which include a full OS.

**What is the purpose of a Dockerfile?**

Dockerfile is a script containing instructions to build a Docker image. Key directives include:

- FROM:** Specifies the base image.
- COPY:** Adds files to the image.
- RUN:** Executes commands during image building.
- CMD:** Defines the default command for the container.

## b) Image Management

**Describe the layers of a Docker image.**

Docker images are built in layers, each representing a step in the

Dockerfile. Layers improve efficiency since unchanged layers are cached and reused.

## **What are the benefits of using Docker volumes?**

Docker volumes allow data persistence beyond the container's lifecycle. Example: In a database container, volumes ensure data remains intact even after the container is deleted.

## **c) Networking in Docker**

### **How does Docker handle networking?**

Docker provides various network modes:

**Bridge:** Default mode, isolates containers which can communicate with each other.

**Host:** Shares the host's network stack.

**None:** Disables networking.

### **How to configure container-to-container communication?**

Create a custom Docker network, attach containers to it, and use container names as hostnames for communication.

# Practical part

## Docker file creation

```
Use Ubuntu as the base image
FROM ubuntu:latest

# Install Nginx and update the package list
RUN apt-get update && apt-get install -y nginx

# Copy the custom index.html file into the container
COPY index.html /var/www/html/index.html

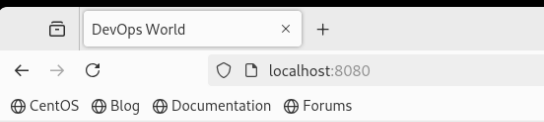
# Expose port 8080 to access Nginx from the host
EXPOSE 8080

# Start Nginx in the foreground (prevents the container from stopping)
CMD ["nginx", "-g", "daemon off;"]
```

```
<!DOCTYPE html>
<html lang="en">
<head>
  <meta charset="UTF-8">
  <meta name="viewport" content="width=device-width, initial-scale=1.0">
  <title>DevOps World</title>
</head>
<body>
  <h1>Welcome to DevOps World!</h1>
</body>
</html>
```

```
[ali@control ~]$
[ali@control ~]$ docker build -t dep1-nginx .
[+] Building 123.1s (8/8) FINISHED
=> [internal] load build definition from Dockerfile
=> => transferring dockerfile: 505B
=> [internal] load metadata for docker.io/library/ubuntu:latest
=> [internal] load .dockerignore
=> => transferring context: 2B
=> [1/3] FROM docker.io/library/ubuntu:latest@sha256:80dd3c3b9c6c9b9f1667e9290b3bc61b78c2678c02cbdae5f8fea9
=> => resolve docker.io/library/ubuntu:latest@sha256:80dd3c3b9c6c9b9f1667e9290b3bc61b78c2678c02cbdae5f8fea92
=> => sha256:6e75a10070bdfcbb0ead763c5118a369bc7cc3bd9c1b6749c491b0b21f15c3c7 424B / 424B
=> => sha256:b1d9df8ab81559494794e522b380878cf90a82d4c1fb67293bcf931c3aa89ae4 2.30kB / 2.30kB
=> => sha256:de44b265507ae44b212defc3b56694d666f136b35c1098d9769968bc861bb2d64 29.75MB / 29.75MB
=> => sha256:80dd3c3b9c6c9b9f1667e9290b3bc61b78c2678c02cbdae5f8fea92cc6734ab 6.69kB / 6.69kB
=> => extracting sha256:de44b265507ae44b212defc3b56694d666f136b35c1098d9769968bc861bb2d64
=> [internal] load build context
=> => transferring context: 342B
=> [2/3] RUN apt-get update && apt-get install -y nginx
=> [3/3] COPY index.html /var/www/html/index.html
=> => exporting to image
=> => exporting layers
=> => writing image sha256:64eea963191ab367d30cb0aa9605eeeb03bbc389b485c06794c0b85f0f8b3a
=> => naming to docker.io/library/dep1-nginx
[ali@control ~]$ docker run -d -p 8080:8080 dep1-nginx
5482ef7d595f98528c4f9a69470b04bed1a2d417721d739e6538aba9df215a3a
[ali@control ~]$ docker ps -a
CONTAINER ID   IMAGE     COMMAND                  CREATED        STATUS        PORTS
5482ef7d595f   dep1-nginx  "nginx -g 'daemon of..." About a minute ago Up About a minute 0.0.0.0:8080->8
```

```
[ali@control ~]$
[ali@control ~]$ docker run -d -p 8080:80 --name task2 dep1-nginx
c6280e7a919c9cfe566c5a2c11347dcafb3fd9d2e9b1526410aad907f21c0f
[ali@control ~]$ docker ps -a
CONTAINER ID   IMAGE     COMMAND                  CREATED        STATUS        PORTS        NAMES
c6280e7a919c   dep1-nginx  "nginx -g 'daemon of..." 54 seconds ago Up 52 seconds 8080/tcp, 0.0.0.0:8080->80/tcp, [::]:8080->80/tcp task2
```



Welcome to DevOps World!

## Multiple container setup

```
version: '3'

services:
  web:
    image: nginx:latest
    container_name: web
    ports:
      - "8080:80"
    volumes:
      - ./html:/usr/share/nginx/html
    networks:
      - webdb_network

  db:
    image: postgres:latest
    container_name: db
    environment:
      POSTGRES_USER: user
      POSTGRES_PASSWORD: password
      POSTGRES_DB: mydatabase
    volumes:
      - db_data:/var/lib/postgresql/data
    networks:
      - webdb_network

volumes:
  db_data:

networks:
  webdb_network:
    driver: bridge
```

```
ali@control ~]$
ali@control ~]$ docker-compose up -d
WARN[0000] /home/ali/docker-compose.yml: the attribute `version` is obsolete, it will be ignored, please remove it to
avoid potential confusion
+-- Running 15/15
+-- db Pulled
+-- fd674058ff8f Pull complete
+-- 1eab12a50bdf Pull complete
+-- 5a81b4aedb94 Pull complete
+-- 502eeeb4a17b Pull complete
+-- e9e19177b318 Pull complete
+-- 2068838cf5fa Pull complete
+-- 45a271dbb114 Pull complete
+-- 8f9ac4ec849d Pull complete
+-- 9d8b60e88ddb Pull complete
+-- 3ec4ef471804 Pull complete
+-- 16d755b48cd4 Pull complete
+-- 3d5d11fb541c Pull complete
+-- d8ab5fe30360 Pull complete
+-- d19370fe7a12 Pull complete
+-- Running 3/4
+-- Network ali_webdb_network Created
+-- Volume "ali_db_data" Created
+-- Container db Started
+-- Container web Starting
error response from daemon: driver failed programming external connectivity on endpoint web (e7c8dea66aa5c298dcf0bf9a
91b7f91c6a02934f490aldaf775605af58440ff): Bind for 0.0.0.0:8080 failed: port is already allocated
```

```
[ali@control ~]$
[ali@control ~]$ docker-compose up -d
WARN[0000] /home/ali/docker-compose.yml: the attribute `version` is obsolete, it will be ignored, please remove it to
avoid potential confusion
+-- Running 2/2
+-- Container web-task2 Started
+-- Container db-task2 Started
```

## Resource limiting

```
[ali@control ~]$
[ali@control ~]$
[ali@control ~]$ docker run -d --name limited-nginx --memory="512m" --cpus="1.0" depi-nginx
bb37b6b50b9d7234d7f2c5ef587f29216620c286875a45763d4215119e718c20
[ali@control ~]$
[ali@control ~]$
[ali@control ~]$ docker stats
```

CONTAINER ID	NAME	CPU %	MEM USAGE / LIMIT	MEM %	NET I/O	BLOCK I/O	PIDS
bb37b6b50b9d	limited-nginx	0.00%	3.379MiB / 512MiB	0.66%	2.5kB / 0B	16MB / 4.1kB	2
8c806fe8be88	db-task2	0.00%	7.617MiB / 926.8MiB	0.82%	2.75kB / 0B	168MB / 22.1MB	6
2d8e597c9da7	web-task2	0.00%	976KiB / 926.8MiB	0.10%	5.92kB / 2.16kB	25.4MB / 2.11MB	2