# Placement Empowerment Program

***Cloud Computing and DevOps Centre***

Containerize a Multi-Tier Application: Create Docker containers for your web application and database. Configure them to communicate using a Docker network.

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## Introduction

In modern software development, applications often follow a **multi-tier architecture**, where different components such as the web application and database run separately to enhance scalability and maintainability. **Containerization** with Docker enables efficient deployment and management of such applications by packaging them with all their dependencies.

This PoC demonstrates how to **containerize a multi-tier application** using **Flask (web application) and MySQL (database)** in Docker on Windows. The goal is to ensure both containers communicate within a Docker network.

## Overview

A **multi-tier application** consists of multiple layers:

1. **Web Application (Flask)** – Handles user interactions and sends queries to the database.
2. **Database (MySQL)** – Stores and manages data.
3. **Docker Network** – Enables communication between containers.

**Key steps in this PoC:**

1. Create a **Docker network** for communication.

2. Build and run a **MySQL database container** with environment variables.

3. Build and run a **Flask web application container** that connects to MySQL.

4. Test communication between the containers.

## Objectives

✔Learn to containerize a web application and database separately.

✔Configure a **Docker network** to enable container communication.

✔ Use **environment variables** to manage database credentials securely.

✔Deploy and test a working **multi-tier application** using Docker.

## Importance

1. **Isolation:** Keeps the web app and database separate for better scalability.

2. **Portability:** Containers can run anywhere, making deployment easy.

3. **Efficiency:** Avoids conflicts between dependencies, ensuring a smooth development workflow.

4. **Scalability:** Supports future extensions like load balancing or additional services.

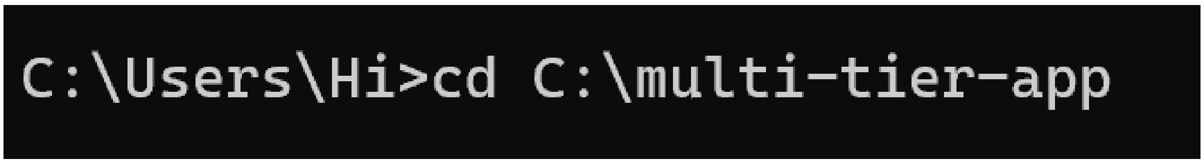
## Step-by-Step Overview

### Step 1:

**Create a Project Folder**

Open **Command Prompt** , then run:

**mkdir C:\multi-tier-app**
**cd C:\multi-tier-app**



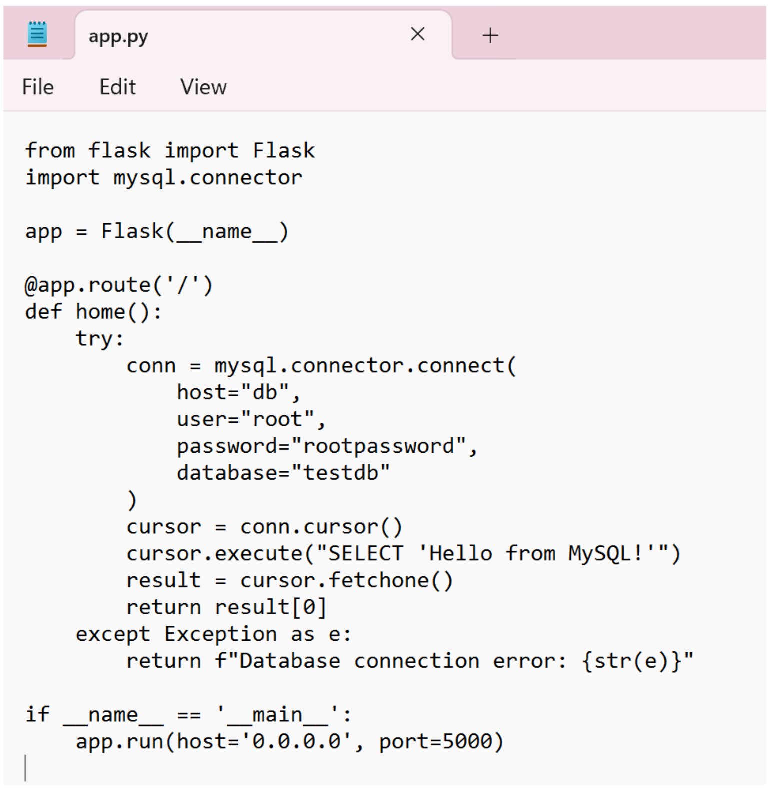
```
C:\Users\Hi>cd C:\multi-tier-app
```

### Step 2:

Create the Flask Web Application

Inside C:\multi-tier-app, create a new Python file:

Create **app.py**

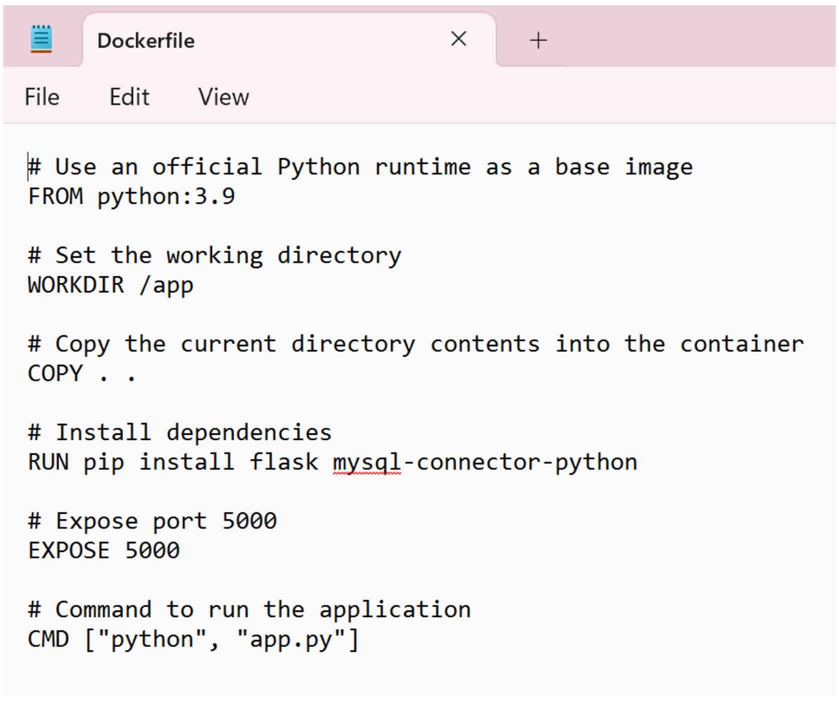


```python
from flask import Flask
import mysql.connector

app = Flask(__name__)

@app.route('/')
def home():
    try:
        conn = mysql.connector.connect(
            host="db",
            user="root",
            password="rootpassword",
            database="testdb"
        )
        cursor = conn.cursor()
        cursor.execute("SELECT 'Hello from MySQL!'")
        result = cursor.fetchone()
        return result[0]
    except Exception as e:
        return f"Database connection error: {str(e)}"

if __name__ == '__main__':
    app.run(host='0.0.0.0', port=5000)
```

## Step 3:

### Create a Dockerfile

In the **same folder**, create a file named Dockerfile (without an extension):

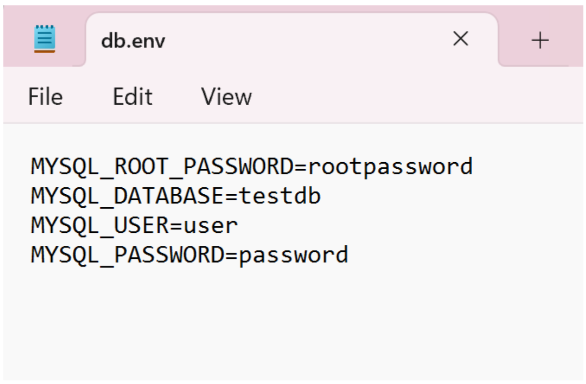


```dockerfile
# Use an official Python runtime as a base image
FROM python:3.9

# Set the working directory
WORKDIR /app

# Copy the current directory contents into the container
COPY . .

# Install dependencies
RUN pip install flask mysql-connector-python

# Expose port 5000
EXPOSE 5000

# Command to run the application
CMD ["python", "app.py"]
```

## Step 4:

**Create the MySQL Database Environment File**

Create a new file named db.env in the same folder:



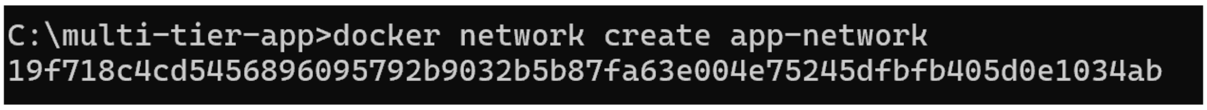
```
MYSQL_ROOT_PASSWORD=rootpassword
MYSQL_DATABASE=testdb
MYSQL_USER=user
MYSQL_PASSWORD=password
```

## Step 5:

Create a Docker Network

Open Command Prompt (cmd) and create a network:

**docker network create app-network**



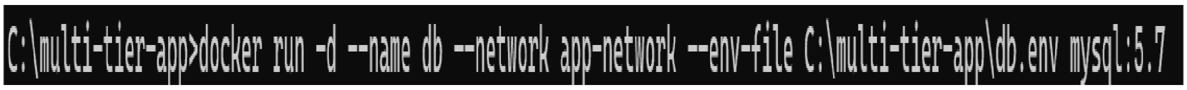
```
C:\multi-tier-app>docker network create app-network
19f718c4cd5456896095792b9032b5b87fa63e004e75245dfbfb405d0e1034ab
```

## Step 6:

Run the MySQL Database Container

Start the MySQL container using the network:

**docker run -d --name db --network app-network --env-file C:\multi-tier-app\db.env mysql:5.7**



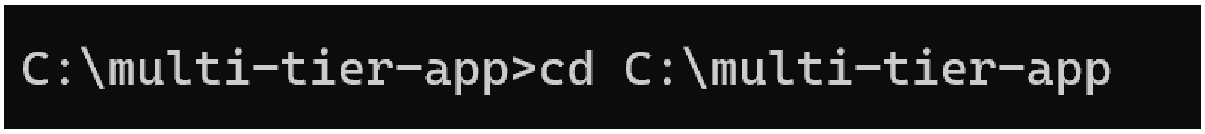
```
C:\multi-tier-app>docker run -d --name db --network app-network --env-file C:\multi-tier-app\db.env mysql:5.7
```

## Step 7:

Build and Run the Flask Web App Container

Navigate to your project folder:

**cd C:\multi-tier-app**

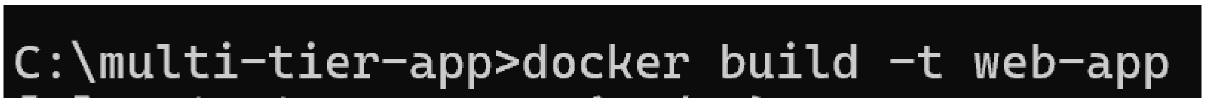


```
C:\multi-tier-app>cd C:\multi-tier-app
```

## Step 8:

Build the Docker image:

**docker build -t web-app .**

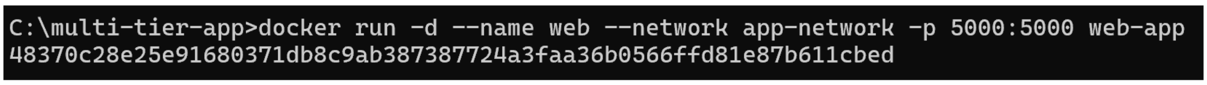


```
C:\multi-tier-app>docker build -t web-app
```

## Step 9:

Run the container and connect it to the network:

**docker run -d --name web --network app-network -p 5000:5000 web-app**



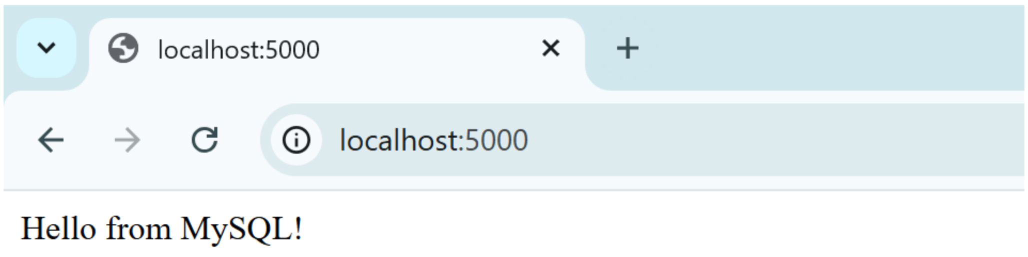
```
C:\multi-tier-app>docker run -d --name web --network app-network -p 5000:5000 web-app
48370c28e25e91680371db8c9ab387387724a3faa36b0566ffd81e87b611cbed
```

## Step 10:

Test the Web App . Open a browser and go to:

**http://localhost:5000**

You should see: Hello from MySQL!



Hello from MySQL!

## Outcomes

By completing this PoC, you will:

1. **Master Multi-Tier Containerization** – Gain hands-on experience in containerizing both a web application and a database separately, ensuring modular and scalable deployments.

2. **Set Up Docker Networking** – Learn how to create and configure a **Docker network** to enable secure communication between application containers.

3. **Work with Environment Variables** – Understand how to securely manage database credentials and configurations using an **env file** in Docker.

4. **Enhance Docker Command Proficiency** – Improve skills in using essential Docker commands like docker network create, docker run, docker build, and docker exec for efficient container management.

5. **Test and Debug Containerized Applications** – Learn how to verify container communication using tools like docker logs and docker exec for debugging and troubleshooting.