Day 4: Kubernetes

Create a products and app.py

```
student@mcacc1-6:~/e-commerce/backend$ cat app.py
import pandas as pd
from flask import Flask

app = Flask(__name__)

@app.route("/products", method=['GET'])
def read_data():
        df = pd.read_csv("./products.csv")
        print(df.head())
        json_data = df.to_json()
        print(json_data)
        return json_data

if __name__ == "__main__":
        app.run(host="0.0.0.0", port=7000)
```

available port numbers

```
~/e-commerce/backend$ sudo netstat -lp
or student:
onnections (only servers)
-Q Local Address           Foreign Address         State       PID/Program name
 0 127.0.0.53:domain       0.0.0.0:*               LISTEN      104/systemd-resolve
 0 localhost:34075         0.0.0.0:*               LISTEN      238/containerd
 0 0.0.0.0:http            0.0.0.0:*               LISTEN      208/nginx: master p
 0 10.255.255.254:domain   0.0.0.0:*               LISTEN      -
 0 127.0.0.54:domain       0.0.0.0:*               LISTEN      104/systemd-resolve
 0 [::]:http               [::]:*                  LISTEN      208/nginx: master p
 0 [::]:http-alt           [::]:*                  LISTEN      151/java
 0 127.0.0.54:domain       0.0.0.0:*                           104/systemd-resolve
 0 127.0.0.53:domain       0.0.0.0:*                           104/systemd-resolve
 0 10.255.255.254:domain   0.0.0.0:*                           -
 0 localhost:323           0.0.0.0:*                           -
 0 ip6-localhost:323       [::]:*                              -
n sockets (only servers)
e       Type       State         I-Node   PID/Program name     Path
t ]     STREAM     LISTENING     25614    2/init               /run/WSL/2_interop
t ]     STREAM     LISTENING     19471    -                    /run/WSL/1_interop
t ]     SEQPACKET  LISTENING     20867    -                    /mnt/wslg/weston-notify.sock
t ]     STREAM     LISTENING     27649    -                    /var/run/dbus/system_bus_socket
t ]     STREAM     LISTENING     24587    -                    /mnt/wslg/runtime-dir/wayland-0
t ]     STREAM     LISTENING     24588    -                    /tmp/.X11-unix/X0
t ]     STREAM     LISTENING     18603    104/systemd-resolve  /run/systemd/resolve/io.systemd.Resolve
t ]     STREAM     LISTENING     18604    104/systemd-resolve  /run/systemd/resolve/io.systemd.Resolve.Monitor
t ]     STREAM     LISTENING     19509    -                    /mnt/wslg/runtime-dir/pulse/native
t ]     STREAM     LISTENING     23832    -                    /mnt/wslg/PulseAudioRDPSource
t ]     STREAM     LISTENING     19682    1/init               /run/apport.socket
t ]     STREAM     LISTENING     19684    1/init               /run/dbus/system_bus_socket
t ]     STREAM     LISTENING     19685    1/init               /run/docker.sock
t ]     STREAM     LISTENING     31887    864/systemd          /run/user/1000/systemd/private
t ]     STREAM     LISTENING     19687    1/init               /run/snapd.socket
t ]     STREAM     LISTENING     31894    864/systemd          /run/user/1000/bus
t ]     STREAM     LISTENING     19688    1/init               /run/snapd-snap.socket
t ]     STREAM     LISTENING     19690    1/init               /run/uuidd/request
t ]     STREAM     LISTENING     31896    864/systemd          /run/user/1000/gnupg/S.dirmngr
t ]     STREAM     LISTENING     31898    864/systemd          /run/user/1000/gnupg/S.gpg-agent.browser
```

Create requirements.txt file

The `requirements.txt` file is used in Python projects to list all the dependencies (packages) that the application needs to run.

```
student@mcacc1-6:~/e-commerce/backend$ nano requirements.txt
student@mcacc1-6:~/e-commerce/backend$ cat requirements.txt
flask
pandas
```

Create docker-compose.yml file

`docker-compose.yml` is a YAML configuration file used to define and run multi-container Docker applications.

```
student@mcacc1-6:~/e-commerce/backend$ nano docker-compose.yml
student@mcacc1-6:~/e-commerce/backend$ cat docker-compose.yml
version: '3.8'

services:
  web:
    build: .
    ports:
      - "7000:7000"
    volumes:
      - .:/app
    restart: always
```

Build Docker image

Sudo docker build -t backend:latest

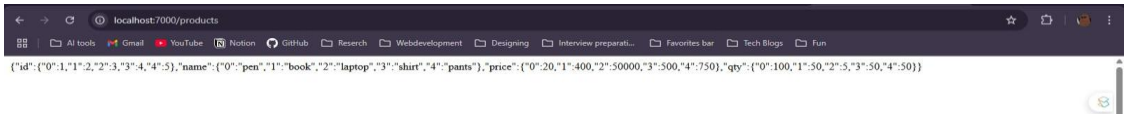
```
student@mcacc1-6:~/e-commerce/backend$ sudo docker build -t backend:latest .
DEPRECATED: The legacy builder is deprecated and will be removed in a future release.
            Install the buildx component to build images with BuildKit:
            https://docs.docker.com/go/buildx/

Sending build context to Docker daemon  6.144kB
Step 1/7 : FROM python:3.11
 ---> 18c0f2265fd9
Step 2/7 : WORKDIR /app
 ---> Using cache
 ---> fef9babcc368
Step 3/7 : COPY requirements.txt .
 ---> e25d384df2aa
Step 4/7 : RUN pip install --no-cache-dir -r requirements.txt
 ---> Running in e75e42a7a000
Collecting flask (from -r requirements.txt (line 1))
  Downloading flask-3.1.0-py3-none-any.whl.metadata (2.7 kB)
Collecting pandas (from -r requirements.txt (line 2))
  Downloading pandas-2.2.3-cp311-cp311-manylinux_2_17_x86_64.manylinux2014_x86_64.whl.metadata (89 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 89.9/89.9 kB 4.1 MB/s eta 0:00:00
Collecting Werkzeug>=3.1 (from flask->-r requirements.txt (line 1))
  Downloading werkzeug-3.1.3-py3-none-any.whl.metadata (3.7 kB)
Collecting Jinja2>=3.1.2 (from flask->-r requirements.txt (line 1))
  Downloading jinja2-3.1.6-py3-none-any.whl.metadata (2.9 kB)
Collecting itsdangerous>=2.2 (from flask->-r requirements.txt (line 1))
  Downloading itsdangerous-2.2.0-py3-none-any.whl.metadata (1.9 kB)
Collecting click>=8.1.3 (from flask->-r requirements.txt (line 1))
  Downloading click-8.1.8-py3-none-any.whl.metadata (2.3 kB)
Collecting blinker>=1.9 (from flask->-r requirements.txt (line 1))
  Downloading blinker-1.9.0-py3-none-any.whl.metadata (1.6 kB)
Collecting numpy>=1.23.2 (from pandas->-r requirements.txt (line 2))
  Downloading numpy-2.2.4-cp311-cp311-manylinux_2_17_x86_64.manylinux2014_x86_64.whl.metadata (62 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 62.0/62.0 kB 29.0 MB/s eta 0:00:00
Collecting python-dateutil>=2.8.2 (from pandas->-r requirements.txt (line 2))
  Downloading python_dateutil-2.9.0.post0-py2.py3-none-any.whl.metadata (8.4 kB)
Collecting pytz>=2020.1 (from pandas->-r requirements.txt (line 2))
  Downloading pytz-2025.1-py2.py3-none-any.whl.metadata (22 kB)
Collecting tzdata>=2022.7 (from pandas->-r requirements.txt (line 2))
  Downloading tzdata-2025.1-py2.py3-none-any.whl.metadata (1.4 kB)
Collecting MarkupSafe>=2.0 (from Jinja2>=3.1.2->flask->-r requirements.txt (line 1))
  Downloading MarkupSafe-3.0.2-cp311-cp311-manylinux_2_17_x86_64.manylinux2014_x86_64.whl.metadata (4.0 kB)
Collecting six>=1.5 (from python-dateutil>=2.8.2->pandas->-r requirements.txt (line 2))
```

Run the docker:

```
student@mcacc1-6:~/e-commerce/backend$ sudo docker run -d -p 7000:7000 backend:latest
93eb47b7c84222454951a1720f5f129131d1d730aa004c48b8dd123101f1bc4a
student@mcacc1-6:~/e-commerce/backend$ sudo docker logs 93eb47b7c84222454951a1720f5f129131d1d730aa004c48b8dd123101f1bc4a
 * Serving Flask app 'app'
 * Debug mode: off
WARNING: This is a development server. Do not use it in a production deployment. Use a production WSGI server instead.
 * Running on all addresses (0.0.0.0)
 * Running on http://127.0.0.1:7000
 * Running on http://172.17.0.2:7000
Press CTRL+C to quit
```

Run the application in the 7000/products



The JSON data is displayed at our port: 7000/products.

Create a container in frontend

Create index.html file and Dockerfile

```
student@mcacc1-6:~/e-commerce/backend$ cd ..
student@mcacc1-6:~/e-commerce$ ls
backend  frontend
student@mcacc1-6:~/e-commerce$ cd frontend/
student@mcacc1-6:~/e-commerce/frontend$ nano index.html
student@mcacc1-6:~/e-commerce/frontend$ nano Dockerfile
student@mcacc1-6:~/e-commerce/frontend$ cat Dockerfile
FROM nginx:alpine
COPY index.html /usr/share/nginx/html/index.html
student@mcacc1-6:~/e-commerce/frontend$
```

Build the image using the command:

sudo docker build -t frontend:latest.

```
student@mcacc1-6:~/e-commerce/frontend$ sudo docker build -t frontend:latest .
[sudo] password for student:
DEPRECATED: The legacy builder is deprecated and will be removed in a future release.
            Install the buildx component to build images with BuildKit:
            https://docs.docker.com/go/buildx/

Sending build context to Docker daemon  3.584kB
Step 1/2 : FROM nginx:alpine
alpine: Pulling from library/nginx
f18232174bc9: Pull complete
ccc35e35d420: Pull complete
43f2ec460bdf: Pull complete
984583bcf083: Pull complete
8d27c072a58f: Pull complete
ab3286a73463: Pull complete
6d79cc6084d4: Pull complete
0c7e4c092ab7: Pull complete
Digest: sha256:4ff102c5d78d254a6f0da062b3cf39eaf07f01eec0927fd21e219d0af8bc0591
Status: Downloaded newer image for nginx:alpine
 ---> 1ff4bb4faebc
Step 2/2 : COPY index.html /usr/share/nginx/html/index.html
 ---> ef6c27374482
Successfully built ef6c27374482
Successfully tagged frontend:latest
```

Kubernetes Deployment YAML Files

Create backend-deployment.yaml file and frontend-deployment.yaml in a folder k8s

```
student@mcacc1-6:~/e-commerce/k8s$ cat backend-deployment.yaml

apiVersion: apps/v1
kind: Deployment
metadata:
  name: backend
spec:
  replicas: 1
  selector:
    matchLabels:
      app: backend
  template:
    metadata:
      labels:
        app: backend
    spec:
      containers:
      - name: backend
        image: backend:latest
        ports:
        - containerPort: 7000
student@mcacc1-6:~/e-commerce/k8s$ cat frontend-deployment.yaml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: frontend
spec:
  replicas: 1
  selector:
    matchLabels:
      app: frontend
  template:
    metadata:
      labels:
        app: frontend
    spec:
      containers:
      - name: frontend
        image: frontend:latest
        ports:
        - containerPort: 7500
student@mcacc1-6:~/e-commerce/k8s$
```

Create service.yaml file

```
student@mcacc1-6:~/e-commerce/k8s$ nano service.yaml
student@mcacc1-6:~/e-commerce/k8s$ cat service.yaml
apiVersion: v1
kind: Service
metadata:
  name: backend-service
spec:
  selector:
    app: backend
  ports:
    - protocol: TCP
      port: 7000
      targetPort: 7000
  type: ClusterIP

apiVersion: v1
kind: Service
metadata:
  name: frontend-service
spec:
  selector:
    app: frontend
  ports:
    - protocol: TCP
      port: 7500
      targetPort: 7500
  type: NodePort
```

Create configmap.yaml file

Stores configuration data as key-value pairs.

```
student@mcacc1-6:~/e-commerce/k8s$ nano configmap.yaml
student@mcacc1-6:~/e-commerce/k8s$ cat configmap.yaml
apiVersion: v1
kind: ConfigMap
metadata:
  name: backend-config
data:
  DATABASE_FILE: "/backend/products.csv"
```

Install minikube

```
student@mcacc1-6:~/e-commerce/k8s$ sudo apt update
[sudo] password for student:
Ign:1 https://pkg.jenkins.io/debian-stable binary/ InRelease
Hit:2 https://pkg.jenkins.io/debian-stable binary/ Release
Get:4 http://security.ubuntu.com/ubuntu noble-security InRelease [126 kB]
Hit:5 http://archive.ubuntu.com/ubuntu noble InRelease
Get:6 http://archive.ubuntu.com/ubuntu noble-updates InRelease [126 kB]
Get:7 http://security.ubuntu.com/ubuntu noble-security/main amd64 Components [8956 B]
Get:8 http://archive.ubuntu.com/ubuntu noble-backports InRelease [126 kB]
Get:9 http://security.ubuntu.com/ubuntu noble-security/universe amd64 Components [51.9 kB]
Get:10 http://security.ubuntu.com/ubuntu noble-security/restricted amd64 Components [212 B]
Get:11 http://security.ubuntu.com/ubuntu noble-security/multiverse amd64 Components [208 B]
Get:12 http://archive.ubuntu.com/ubuntu noble-updates/main amd64 Components [151 kB]
Get:13 http://archive.ubuntu.com/ubuntu noble-updates/universe amd64 Components [364 kB]
Get:14 http://archive.ubuntu.com/ubuntu noble-updates/restricted amd64 Components [212 B]
Get:15 http://archive.ubuntu.com/ubuntu noble-updates/multiverse amd64 Components [940 B]
Get:16 http://archive.ubuntu.com/ubuntu noble-backports/main amd64 Components [208 B]
Get:17 http://archive.ubuntu.com/ubuntu noble-backports/universe amd64 Components [19.9 kB]
Get:18 http://archive.ubuntu.com/ubuntu noble-backports/restricted amd64 Components [216 B]
Get:19 http://archive.ubuntu.com/ubuntu noble-backports/multiverse amd64 Components [212 B]
Fetched 976 kB in 2s (412 kB/s)
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
28 packages can be upgraded. Run 'apt list --upgradable' to see them.
student@mcacc1-6:~/e-commerce/k8s$ docker -v
Docker version 26.1.3, build 26.1.3-0ubuntu1~24.04.1
student@mcacc1-6:~/e-commerce/k8s$ sudo apt install docker.io -y
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
docker.io is already the newest version (26.1.3-0ubuntu1~24.04.1).
0 upgraded, 0 newly installed, 0 to remove and 28 not upgraded.
student@mcacc1-6:~/e-commerce/k8s$ docker -v
Docker version 26.1.3, build 26.1.3-0ubuntu1~24.04.1
student@mcacc1-6:~/e-commerce/k8s$ curl -LO https://storage.googleapis.com/minikube/releases/latest/minikube-linux-amd64
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
 25  119M   25 30.2M    0     0  1335k      0  0:01:31  0:00:23  0:01:08 1276k
```

Install kubectl

```
student@mcacc1-6:~/e-commerce/k8s$ curl -LO "https://dl.k8s.io/release/$(curl -L -s https://dl.k8s.io/release/stable.txt)/bin/linux/amd64/kubectl"
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100   138  100   138    0     0    424      0 --:--:-- --:--:-- --:--:--   425
 71 54.6M   71 39.3M    0     0   671k      0  0:01:23  0:00:59  0:00:24  594k
```

Grant permission for kubectl

chmod +x kubectl

Move to kubectl to root

```
student@mcacc1-6:~/e-commerce/k8s$ sudo mv kubectl/usr/local/bin/
mv: missing destination file operand after 'kubectl/usr/local/bin/'
Try 'mv --help' for more information.
student@mcacc1-6:~/e-commerce/k8s$ sudo mv kubectl /usr/local/bin/
student@mcacc1-6:~/e-commerce/k8s$
```

Check the minikube and kubectl installed properly

```
student@mcacc1-6:~$ kubectl version
Client Version: v1.32.3
Kustomize Version: v5.5.0
Error from server (Forbidden): <html><head><meta http-equiv='refresh' content='1;url=/login?from=%2Fversion%3Ftimeout%3D32s'/><script id='redirect' data-redirect-url='/login?
from=%2Fversion%3Ftimeout%3D32s' src='/static/dad96ebf/scripts/redirect.js'></script></head><body style='background-color:white; color:white;'>
Authentication required
<!--
-->

</body></html>
student@mcacc1-6:~$ minikube version
minikube version: v1.35.0
commit: dd5d320e41b5451cdf3c01891bc4e13d189586ed-dirty
```

Start minicube: minikube start

```
student@mcacc1-6:~$ minikube start
😄  minikube v1.35.0 on Ubuntu 24.04 (amd64)
✨  Using the docker driver based on existing profile
👍  Starting "minikube" primary control-plane node in "minikube" cluster
🚜  Pulling base image v0.0.46 ...
🏃  Updating the running docker "minikube" container ...
🐳  Preparing Kubernetes v1.32.0 on Docker 27.4.1 ...
🔎  Verifying Kubernetes components...
    ▪ Using image gcr.io/k8s-minikube/storage-provisioner:v5
🌟  Enabled addons: storage-provisioner, default-storageclass
🏄  Done! kubectl is now configured to to use "minikube" cluster and "default" namespace by default
```

Verify minikube is running

```
student@mcacc1-6:~$ kubectl get nodes
NAME       STATUS   ROLES           AGE    VERSION
minikube   Ready    control-plane   119s   v1.32.0
```

Load the image to the minikube

Befor loading images

Perform this commend: eval $(minikube docker-env)

minikube image load frontend:latest

minikube image load backend:latest

Check the images are loaded

```
student@mcacc1-6:~/kubernetes/backend$ docker images | grep backend
backend                      latest    2c8028c02a4e   27 hours ago   1.17GB
student@mcacc1-6:~/kubernetes/backend$ cd ../frontend/
student@mcacc1-6:~/kubernetes/frontend$ docker images | grep frontend
frontend                     latest    ef6c273744d2   24 hours ago   47.9MB
```

```
student@mcacc1-6:~/kubernetes/k8s$ kubectl apply -f backend-deployment.yaml
deployment.apps/backend created
student@mcacc1-6:~/kubernetes/k8s$ kubectl apply -f k8s/frontend-deployment.yaml
error: the path "k8s/frontend-deployment.yaml" does not exist
student@mcacc1-6:~/kubernetes/k8s$ kubectl apply -f frontend-deployment.yaml
deployment.apps/frontend created
student@mcacc1-6:~/kubernetes/k8s$ kubectl apply -f k8s/service.yaml
error: the path "k8s/service.yaml" does not exist
student@mcacc1-6:~/kubernetes/k8s$ kubectl apply -f service.yaml
service/backend-service created
service/frontend-service created
student@mcacc1-6:~/kubernetes/k8s$ kubectl apply -f configmap.yaml
configmap/backend-config created
student@mcacc1-6:~/kubernetes/k8s$
```

```
student@mcacc1-6:~/kubernetes/k8s$ kubectl get pods
NAME                       READY   STATUS    RESTARTS   AGE
backend-dfd8d5579-xz2xp    1/1     Running   0          3m46s
frontend-6cfd7c46-dsj9c    1/1     Running   0          3m14s
student@mcacc1-6:~/kubernetes/k8s$ kubectl get svc
NAME               TYPE        CLUSTER-IP       EXTERNAL-IP   PORT(S)          AGE
backend-service    ClusterIP   10.104.89.56     <none>        5000/TCP         3m12s
frontend-service   NodePort    10.105.136.172   <none>        3000:30520/TCP   3m12s
kubernetes         ClusterIP   10.96.0.1        <none>        443/TCP          3h53m
```

To test Frontend

```
student@mcacc1-6:~/kubernetes/k8s$ minikube service frontend-service --url
http://127.0.0.1:37341
❗  Because you are using a Docker driver on linux, the terminal needs to be open to run it.
```

To Test backend

```
student@mcacc1-6:~/kubernetes/k8s$ kubectl run test-pod --image=alpine --restart=Never -it -- sh
If you don't see a command prompt, try pressing enter.
/ # kubectl get pod test-pod
sh: kubectl: not found
/ # kubectl exec -it test-pod -- sh
sh: kubectl: not found
/ # apk add curl
fetch https://dl-cdn.alpinelinux.org/alpine/v3.21/main/x86_64/APKINDEX.tar.gz
fetch https://dl-cdn.alpinelinux.org/alpine/v3.21/community/x86_64/APKINDEX.tar.gz
(1/9) Installing brotli-libs (1.1.0-r2)
(2/9) Installing c-ares (1.34.3-r0)
(3/9) Installing libunistring (1.2-r0)
(4/9) Installing libidn2 (2.3.7-r0)
(5/9) Installing nghttp2-libs (1.64.0-r0)
(6/9) Installing libpsl (0.21.5-r3)
(7/9) Installing zstd-libs (1.5.6-r2)
(8/9) Installing libcurl (8.12.1-r1)
(9/9) Installing curl (8.12.1-r1)
Executing busybox-1.37.0-r12.trigger
OK: 12 MiB in 24 packages
/ # curl http://backend-service:5000/products
{"id":{"0":1,"1":2,"2":3,"3":4,"4":5},"name":{"0":"pen","1":"book","2":"laptop","3":"shirt","4":"pants"},"price":{"0":20,"1":400,"2":50000,"3":500,"4":750},"qty":{"0":100,"1"
:50,"2":5,"3":50,"4":50}}/ #
```

Store