# DevOps

# Day 4: Kubernetes

## Create a directory ‘e-commerce’ and its required folders and files

Create products.csv file and app.py

```
aravind@Aravind: ~/ecomme
aravind@Aravind:~$ mkdir ecommerce
aravind@Aravind:~$ cd ecommerce
aravind@Aravind:~/ecommerce$ mkdir frontend backend
aravind@Aravind:~/ecommerce$ ls
backend  frontend
aravind@Aravind:~/ecommerce$ cd backend
aravind@Aravind:~/ecommerce/backend$ nano products.csv
aravind@Aravind:~/ecommerce/backend$ cat products.csv
id, name, price, qty

1, pen, 20, 100
2, book, 400, 56
3, laptop, 50000, 5,
4, shirt, 500, 50,
5, pants, 750, 56
aravind@Aravind:~/ecommerce/backend$ nano app.py
```

```
aravind@Aravind:~/ecommerce/backend$ nano app.py
aravind@Aravind:~/ecommerce/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)
```

To Install Python

```
aravind@Aravind: ~/ecomme
aravind@Aravind:~/ecommerce/backend$ sudo apt install python3-pip
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  build-essential bzip2 cpp cpp-13 cpp-13-x86-64-linux-gnu cpp-x86-64-linux-gnu dpkg-dev fakeroot g++ g++-13 g++-13-x86-64-linux-gnu g++-x86-64-linux-gnu
  gcc gcc-13 gcc-13-base gcc-13-x86-64-linux-gnu gcc-x86-64-linux-gnu javascript-common libalgorithm-diff-perl libalgorithm-diff-xs-perl
  libalgorithm-merge-perl libaom3 libasan8 libatomic1 libc-dev-bin libc-devtools libc6-dev libcc1-0 libcrypt-dev libde265-0 libdpkg-perl libexpat1-dev
  libfakeroot libfile-fcntllock-perl libgcc-13-dev libgd3 libgomp1 libheif-plugin-aomdec libheif-plugin-aomenc libheif-plugin-libde265 libheif1 libhwasan0
  libisl23 libitm1 libjs-jquery libjs-sphinxdoc libjs-underscore liblsan0 libmpc3 libpython3-dev libpython3.12-dev libquadmath0 libstdc++-13-dev libtsan2
  libubsan1 linux-libc-dev lto-disabled-list make manpages-dev python3-dev python3-wheel python3.12-dev rpcsvc-proto zlib1g-dev
Suggested packages:
  bzip2-doc cpp-doc gcc-13-locales cpp-13-doc debian-keyring g++-multilib g++-13-multilib gcc-13-doc gcc-multilib autoconf automake libtool flex bison gdb
  gcc-doc gcc-13-multilib gdb-x86-64-linux-gnu glibc-doc bzr libgd-tools libheif-plugin-x265 libheif-plugin-ffmpegdec libheif-plugin-jpegdec
  libheif-plugin-jpegenc libheif-plugin-j2kdec libheif-plugin-j2kenc libheif-plugin-rav1e libheif-plugin-svtenc libstdc++-13-doc make-doc
The following NEW packages will be installed:
  build-essential bzip2 cpp cpp-13 cpp-13-x86-64-linux-gnu cpp-x86-64-linux-gnu dpkg-dev fakeroot g++ g++-13 g++-13-x86-64-linux-gnu g++-x86-64-linux-gnu
  gcc gcc-13 gcc-13-base gcc-13-x86-64-linux-gnu gcc-x86-64-linux-gnu javascript-common libalgorithm-diff-perl libalgorithm-diff-xs-perl
  libalgorithm-merge-perl libaom3 libasan8 libatomic1 libc-dev-bin libc-devtools libc6-dev libcc1-0 libcrypt-dev libde265-0 libdpkg-perl libexpat1-dev
  libfakeroot libfile-fcntllock-perl libgcc-13-dev libgd3 libgomp1 libheif-plugin-aomdec libheif-plugin-aomenc libheif-plugin-libde265 libheif1 libhwasan0
  libisl23 libitm1 libjs-jquery libjs-sphinxdoc libjs-underscore liblsan0 libmpc3 libpython3-dev libpython3.12-dev libquadmath0 libstdc++-13-dev libtsan2
  libubsan1 linux-libc-dev lto-disabled-list make manpages-dev python3-dev python3-pip python3-wheel python3.12-dev rpcsvc-proto zlib1g-dev
0 upgraded, 65 newly installed, 0 to remove and 28 not upgraded.
Need to get 81.3 MB of archives.
After this operation, 284 MB of additional disk space will be used.
Do you want to continue? [Y/n] y
Ign:1 http://archive.ubuntu.com/ubuntu noble-updates/main amd64 libc-dev-bin amd64 2.39-0ubuntu8.4
Ign:2 http://archive.ubuntu.com/ubuntu noble-updates/main amd64 linux-libc-dev amd64 6.8.0-55.57
Ign:3 http://archive.ubuntu.com/ubuntu noble/main amd64 libcrypt-dev amd64 1:4.4.36-4build1
Get:4 http://archive.ubuntu.com/ubuntu noble/main amd64 rpcsvc-proto amd64 1.4.2-0ubuntu7 [67.4 kB]
Get:5 http://archive.ubuntu.com/ubuntu noble-updates/main amd64 libc6-dev amd64 2.39-0ubuntu8.4 [2124 kB]
Get:6 http://archive.ubuntu.com/ubuntu noble-updates/main amd64 gcc-13-base amd64 13.3.0-6ubuntu2~24.04 [51.5 kB]
Get:7 http://archive.ubuntu.com/ubuntu noble-updates/main amd64 libisl23 amd64 0.26-3build1.1 [680 kB]
Get:8 http://archive.ubuntu.com/ubuntu noble-updates/main amd64 libmpc3 amd64 1.3.1-1build1.1 [54.6 kB]
Get:9 http://archive.ubuntu.com/ubuntu noble-updates/main amd64 cpp-13-x86-64-linux-gnu amd64 13.3.0-6ubuntu2~24.04 [10.7 MB]
Get:10 http://archive.ubuntu.com/ubuntu noble-updates/main amd64 cpp-13 amd64 13.3.0-6ubuntu2~24.04 [1038 B]
Get:11 http://archive.ubuntu.com/ubuntu noble/main amd64 cpp-x86-64-linux-gnu amd64 4:13.2.0-7ubuntu1 [5326 B]
Get:12 http://archive.ubuntu.com/ubuntu noble/main amd64 cpp amd64 4:13.2.0-7ubuntu1 [22.4 kB]
Get:13 http://archive.ubuntu.com/ubuntu noble-updates/main amd64 libcc1-0 amd64 14.2.0-4ubuntu2~24.04 [48.0 kB]
Get:14 http://archive.ubuntu.com/ubuntu noble-updates/main amd64 libgomp1 amd64 14.2.0-4ubuntu2~24.04 [148 kB]
Get:15 http://archive.ubuntu.com/ubuntu noble-updates/main amd64 libitm1 amd64 14.2.0-4ubuntu2~24.04 [29.7 kB]
Get:16 http://archive.ubuntu.com/ubuntu noble-updates/main amd64 libatomic1 amd64 14.2.0-4ubuntu2~24.04 [10.5 kB]
Get:17 http://archive.ubuntu.com/ubuntu noble-updates/main amd64 libasan8 amd64 14.2.0-4ubuntu2~24.04 [3031 kB]
Get:18 http://archive.ubuntu.com/ubuntu noble-updates/main amd64 liblsan0 amd64 14.2.0-4ubuntu2~24.04 [1322 kB]
```

Install the pandas library:

```
aravind@Aravind:~/ecommerce/k8s$ sudo apt install python3-pandas
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  blt fonts-lyx isympy-common isympy3 libaec0 libblas3 libblosc1 libblosc2-2t64 libgfortran5 libhdf5-103-1t64 libimagequant0 libjs-jquery-ui liblapack3
  liblbfgsb0 libopenjp2-7 libqhull-r8.0 libraqm0 libsnappy1v5 libsz2 libtcl8.6 libtk8.6 libwebpdemux2 libwebpmux3 libxss1 python-matplotlib-data
  python-odf-doc python-odf-tools python-tables-data python3-appdirs python3-bottleneck python3-brotli python3-bs4 python3-contourpy python3-cpuinfo
  python3-cssselect python3-cycler python3-dateutil python3-decorator python3-defusedxml python3-et-xmlfile python3-fonttools python3-fs python3-html5lib
  python3-kiwisolver python3-lxml python3-lz4 python3-matplotlib python3-mpmath python3-numexpr python3-numpy python3-odf python3-olefile python3-openpyxl
  python3-packaging python3-pandas-lib python3-pil python3-pil.imagetk python3-scipy python3-soupsieve python3-sympy python3-tables python3-tables-lib
  python3-tk python3-ufolib2 python3-unicodedata2 python3-webencodings tk8.6-blt2.5 unicode-data
Suggested packages:
  blt-demo libjs-jquery-ui-docs tcl8.6 tk8.6 python-bottleneck-doc python-cycler-doc python3-genshi python-lxml-doc cm-super-minimal dvipng ffmpeg
  fonts-staypuft ghostscript gir1.2-gtk-3.0 inkscape ipython3 python3-cairocffi python3-gi-cairo python3-gobject python3-pyqt5 python3-sip python3-tornado
  texlive-extra-utils texlive-latex-extra python-mpmath-doc python3-gmpy2 gfortran python3-pytest python-openpyxl-doc python-pandas-doc
  python3-statsmodels python-pil-doc python-scipy-doc texlive-fonts-extra python-sympy-doc python3-netcdf4 python-tables-doc vitables tix python3-tk-dbg
Recommended packages:
  python3-numba
The following NEW packages will be installed:
  blt fonts-lyx isympy-common isympy3 libaec0 libblas3 libblosc1 libblosc2-2t64 libgfortran5 libhdf5-103-1t64 libimagequant0 libjs-jquery-ui liblapack3
  liblbfgsb0 libopenjp2-7 libqhull-r8.0 libraqm0 libsnappy1v5 libsz2 libtcl8.6 libtk8.6 libwebpdemux2 libwebpmux3 libxss1 python-matplotlib-data
  python-odf-doc python-odf-tools python-tables-data python3-appdirs python3-bottleneck python3-brotli python3-bs4 python3-contourpy python3-cpuinfo
  python3-cssselect python3-cycler python3-dateutil python3-decorator python3-defusedxml python3-et-xmlfile python3-fonttools python3-fs python3-html5lib
  python3-kiwisolver python3-lxml python3-lz4 python3-matplotlib python3-mpmath python3-numexpr python3-numpy python3-odf python3-olefile python3-openpyxl
  python3-packaging python3-pandas python3-pandas-lib python3-pil python3-pil.imagetk python3-scipy python3-soupsieve python3-sympy python3-tables
  python3-tables-lib python3-tk python3-ufolib2 python3-unicodedata2 python3-webencodings tk8.6-blt2.5 unicode-data
0 upgraded, 69 newly installed, 0 to remove and 30 not upgraded.
Need to get 64.9 MB of archives.
After this operation, 290 MB of additional disk space will be used.
Do you want to continue? [Y/n] y
Get:1 http://archive.ubuntu.com/ubuntu noble/main amd64 libtcl8.6 amd64 8.6.14+dfsg-1build1 [988 kB]
```

Ensure that the CSV file is read and correctly parsed into JSON format

Create Dockerfile and requirements.txt

```
aravind@Aravind:~/ecommerce/backend$ nano Dockerfile
aravind@Aravind:~/ecommerce/backend$ nano requirements.txt
aravind@Aravind:~/ecommerce/backend$ cat requirements.txt
flask
pandas
aravind@Aravind:~/ecommerce/backend$ cat Dockerfile
FROM python:3.11

# Set the working directory in the container
WORKDIR /app

# Copy the requirements file and install dependencies
COPY requirements.txt .
RUN pip install --no-cache-dir -r requirements.txt

# Copy the application source code
COPY . .

# Expose the port the app runs on
EXPOSE 5000

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

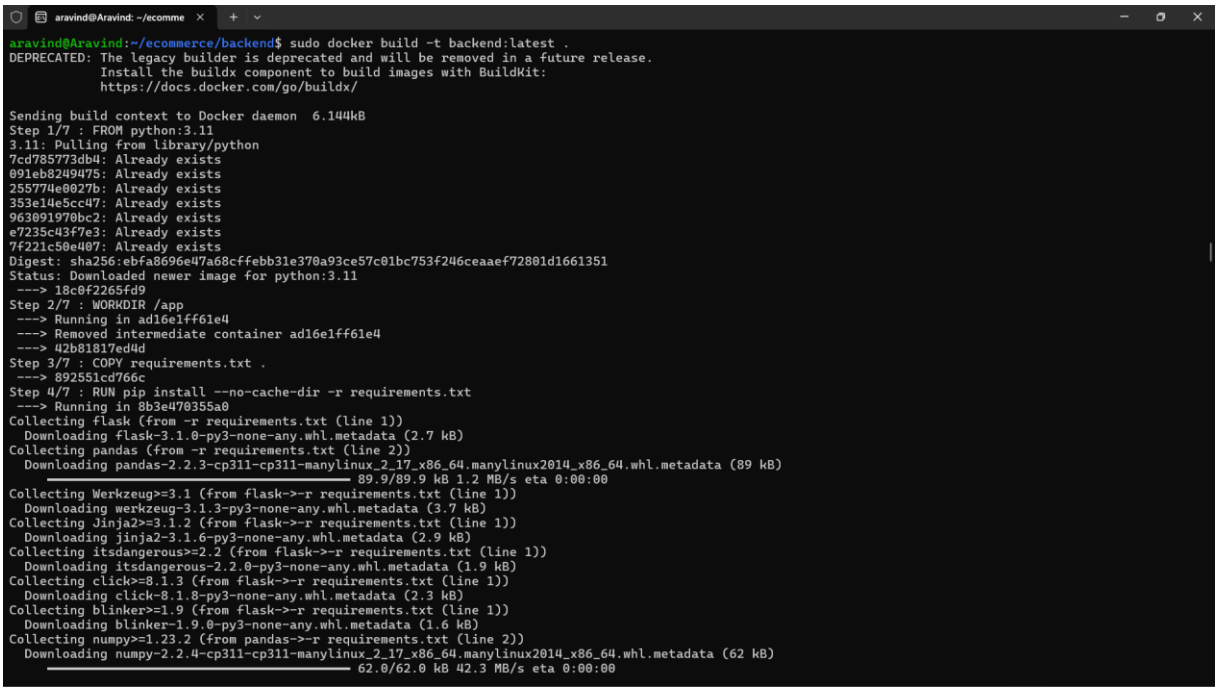
Create docker-compose.yml

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

# Build Docker image

Sudo docker build -t backend:latest




Run the docker:

sudo docker run -d -p 7000:7000 backend:latest

sudo docker logs <Generated number>


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**

```
aravind@Aravind:~/ecommerce/backend$ cd ..
aravind@Aravind:~/ecommerce$ cd frontend
aravind@Aravind:~/ecommerce/frontend$ nano index.html
aravind@Aravind:~/ecommerce/frontend$ nano Dockerfile
aravind@Aravind:~/ecommerce/frontend$ cat Dockerfile
FROM nginx:alpine
COPY index.html /usr/share/nginx/html/index.html
```

Build the image using the command:
sudo docker build -t frontend:latest.

```
aravind@Aravind:~/ecommerce/frontend$ sudo docker build -t fronend: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  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
 ---> 6cd8d2ba7a32
Successfully built 6cd8d2ba7a32
Successfully tagged fronend:latest
```

---

# Kubernetes Deployment YAML Files

Create **backend-deployment.yaml file** and **frontend-deployment.yaml**

```
aravind@Aravind:~/ecommerce/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: 5000
```

```
aravind@Aravind:~/ecommerce/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: 4000
```

Create **service.yaml** file

```
aravind@Aravind:~/ecommerce/k8s$ nano service.yaml
aravind@Aravind:~/ecommerce/k8s$ cat service.yaml
apiVersion: v1
kind: Service
metadata:
  name: backend-service
spec:
  selector:
    app: backend
  ports:
    - protocol: TCP
      port: 5000
      targetPort: 5000
  type: ClusterIP

apiVersion: v1
kind: Service
metadata:
  name: frontend-service
spec:
  selector:
    app: frontend
  ports:
    - protocol: TCP
      port: 3000
      targetPort: 80
  type: NodePort
```

Create **configmap.yaml** file

```
aravind@Aravind:~/ecommerce/k8s$ nano configmap.yaml
aravind@Aravind:~/ecommerce/k8s$ cat configmap.yaml
apiVersion: v1
kind: ConfigMap
metadata:
  name: backend-config
data:
  DATABASE_FILE: "/backend/products.csv"
```

Install minikube

```
aravind@Aravind:~/ecommerce/k8s$ sudo apt update
Ign:1 https://pkg.jenkins.io/debian-stable binary/ InRelease
Hit:2 https://pkg.jenkins.io/debian-stable binary/ Release
Hit:4 http://security.ubuntu.com/ubuntu noble-security InRelease
Hit:5 http://archive.ubuntu.com/ubuntu noble InRelease
Hit:6 http://archive.ubuntu.com/ubuntu noble-updates InRelease
Hit:7 http://archive.ubuntu.com/ubuntu noble-backports InRelease
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
30 packages can be upgraded. Run 'apt list --upgradable' to see them.
aravind@Aravind:~/ecommerce/k8s$ docker -v
Docker version 26.1.3, build 26.1.3-0ubuntu1~24.04.1
aravind@Aravind:~/ecommerce/k8s$ sudo apt install docker.io .
Reading package lists... Done
E: Unsupported file . given on commandline
aravind@Aravind:~/ecommerce/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 30 not upgraded.
aravind@Aravind:~/ecommerce/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
100  119M  100  119M    0     0  4700k      0  0:00:26  0:00:26 --:--:-- 6205k
```

Install kubectl

```
aravind@Aravind:~/ecommerce/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    295      0 --:--:-- --:--:-- --:--:--   295
100   238  100   238    0     0    249      0 --:--:-- --:--:-- --:--:--   641
```

Grant permission

**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 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    ef6c273744482   24 hours ago   47.9MB
```

Commands are used to deploy your application components (backend and frontend), expose them through a service, and provide them with the necessary configuration via a ConfigMap.

```
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$
```

These commands are used to list and inspect the running resources in your Kubernetes cluster:

**kubectl get pods**

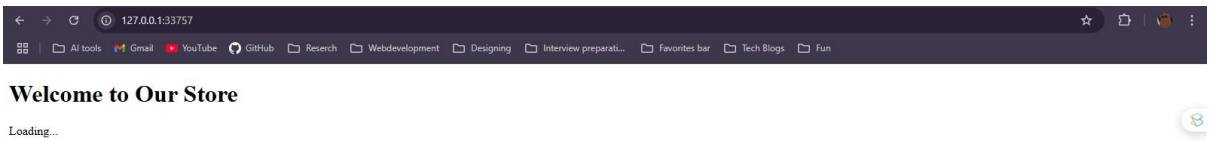
**kubectl get svc**

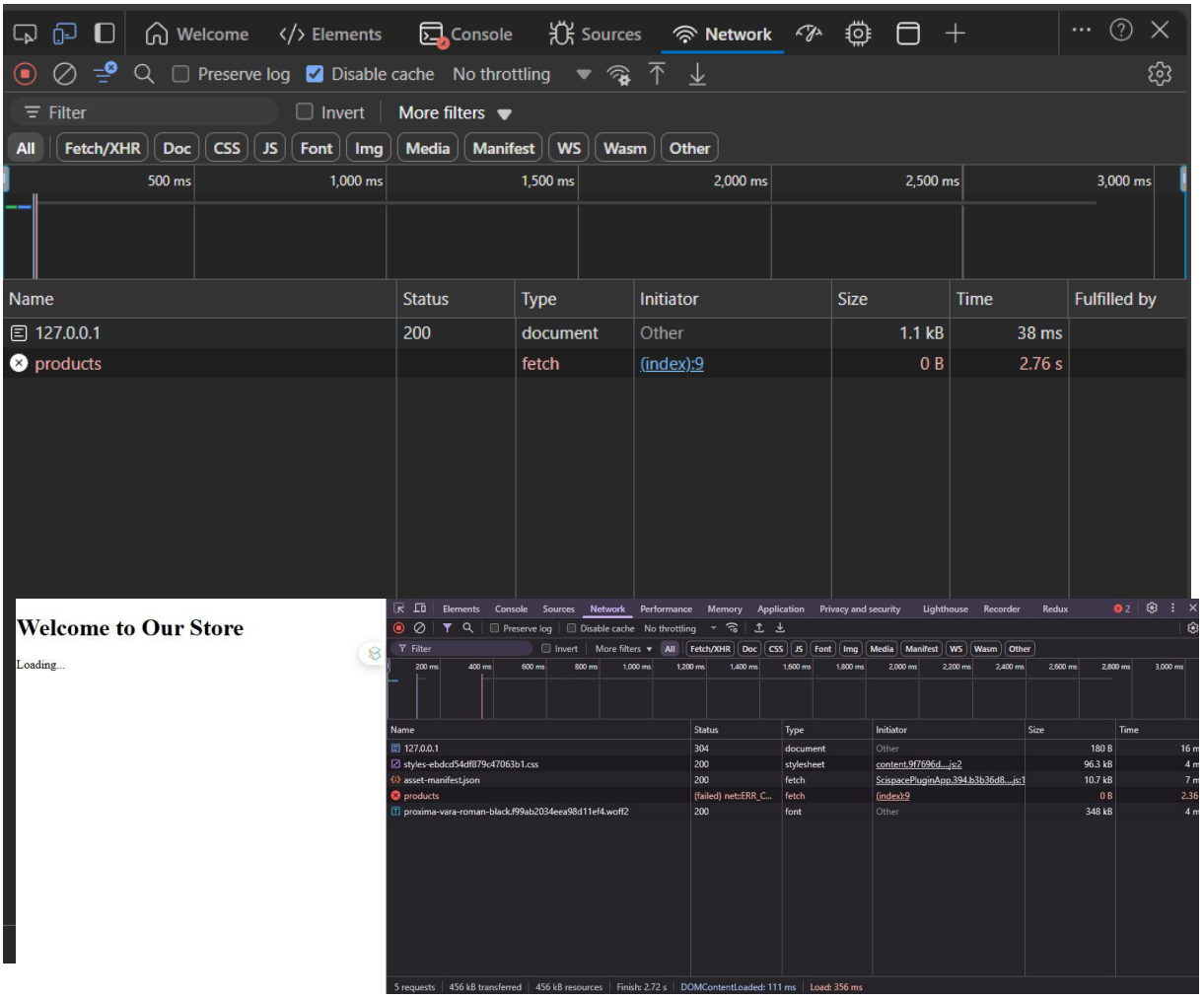
```
student@mcacc1-6:~/kubernetes/k8s$ kubectl get pods
NAME                        READY   STATUS    RESTARTS   AGE
backend-dfd8d5579-xz2xp     1/1     Running   0          3m46s
frontend-6cfd7c46-dsj9c     1/1     Running   0          3m14s
student@mcacc1-6:~/kubernetes/k8s$ kubectl get svc
NAME               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.
```

**Output**






Note: We expect this kind of output because we are running this frontend on localhost.