[Tutorial]: Serve a Containerised ML Model using FastAPI and Docker

Ashmi Banerjee · Follow

5 min read · Sep 3, 2022

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> *A step-by-step tutorial to serve a containerised Machine Learning (ML) model using FastAPI and docker.*

Our tech stack for the tutorial

In my ***previous*** tutorial, we journeyed through building end-points to serve a machine learning (**ML**) model for an image classifier using

Python and *FastAPI*.

In this follow-up tutorial, we will focus on containerising the model using docker when serving through FastAPI.

> If you have followed my **last tutorial** on serving a pre-trained image classifier model from TensorFlow Hub using FastAPI, then you can **directly jump** to **Step 3** ⬇️ of this tutorial.😉

[Tutorial]: Serve an ML Model in Production using FastAPI

A step-by-step tutorial to serve a (pre-trained) image classifier model from TensorFlow Hub using FastAPI.

medium.com

Advantages of Containerisation

It works on my machine — a popular docker meme on the internet

Containerisation offers the following advantages:

1. **Performance consistency**
   DevOps teams know applications in containers will run the same, regardless of where they are deployed.
2. **Greater efficiency**
   Containers allow applications to be more rapidly deployed, patched,

or scaled.

3. **Less overhead**
   Containers require fewer system resources than traditional or hardware virtual machine environments because they don't include operating system images.

Methodology

We can achieve this using 2 approaches here.

1. Implements a `Dockerfile` which needs to be `built` manually every time there is a change in the code and then separately executed.
2. Automating the aforementioned process using `docker-compose`

Step 0: Prerequisites

1. Python 3.6+
2. You have ***docker*** installed.
3. Create the project structure as follows

```
fastapi-backend
├── src
│   ├── app
│   │   ├── app.py
│   └── pred
│   │   ├── models
│   │   │   ├── tf_pred.py
│   │   └── image_classifier.py
│   └── utils
│   │   ├── utilities.py
│   └── main.py
├── Dockerfile
├── docker-compose.yml
└── requirements.txt
```

Step 1: Setup

In the `app.py` file, implement the `/predict/tf/` end-point using `FastAPI`.

```python
from fastapi import FastAPI, HTTPException
from src.pred.image_classifier import *
from pydantic import BaseModel

app = FastAPI(title="Image Classifier API")

class Img(BaseModel):
    img_url: str

@app.post("/predict/tf/", status_code=200)
async def predict_tf(request: Img):
    prediction = tf_run_classifier(request.img_url)
    if not prediction:
        # the exception is raised, not returned - you will get a validation
        # error otherwise.
        raise HTTPException(
            status_code=404, detail="Image could not be downloaded"
        )
    return prediction
```

app.py hosted with ❤ by GitHub view raw

In the `main.py` file, we use the `uvicorn` server, which is an ASGI web server implementation for Python.

```python
import uvicorn

if __name__ == "__main__":
    uvicorn.run("app:app", host="0.0.0.0", port=8000, log_level="debug",
                proxy_headers=True, reload=True)
```

[fastapi_docker]main.py hosted with ❤ by **GitHub** **view raw**

Note: *Since the goal of the tutorial is to containerise the application, the detailed explanation of the above snippet has been explained in the* ***Step 2*** *of the* ***previous*** *tutorial.*

Step 2: Create a Dockerfile

The first step to containerise an application is to create a Dockerfile in your project directory *(see project structure above)*.

`Dockerfile` is a text document containing all instructions required to build a docker image.

We define our `Dockerfile` as follows:

```
FROM python:3-buster

RUN pip install --upgrade pip
WORKDIR /code

COPY ./requirements.txt /code/requirements.txt
RUN pip install --no-cache-dir --upgrade -r /code/requirements.txt

COPY ./src ./src/
COPY ./src/main.py ./main.py
COPY ./src/app/app.py ./app.py

CMD ["python", "main.py"]
```

[fastapi_docker]Dockerfile hosted with ❤ by **GitHub** **view raw**

Explanations:

- `Line 1` : Downloads the specified Docker image (`python:3-buster`) from the ***docker hub registry***. You can check out the available images ***here***.

- `Line 3` : Upgrades `pip` so that later we can install the `requirements.txt`

- `Line 6` : Copies `requirements.txt` file and its content from the host to container

- `Line 7` : Installs the contents of `requirements.txt` inside the image

- `Lines 9-12` : Copies the respective files from the host to the image

- `Line 13` : CMD (executable) instruction is used to set a command to be executed when running a container. A `Dockerfile` must have only one CMD instruction and in case of multiple ones only the last one takes effect. This statement also sets the default command for the container to `python main.py` .

Step 4: Build and Run your App

Once we have implemented our Dockerfile, the next step is to `build` the docker image and then `run` it.

Step 4.1. Build the image

We build the image (here `myfastapiimage`) as follows.
You can call it by any name of your choice.

```
docker build -t myfastapiimage .
```

Important points to note:

- Do not forget the `.` after the image
- In case your docker image fails to rebuild after changing the files, you can initiate a forced build as follows:

```
docker build --no-cache -t myfastapiimage .
```

`docker build` usually uses cache to speed things up. `--no-cache` makes sure that it forcefully rebuilds it.

Step 4.2. Run the container

```
docker run --name mycontainer -p 80:8000 myfastapiimage
```

Explanations

- `docker run --name <myContainerName>` : creates a container named `mycontainer` (you can use any name here). The name of the container is later used for identification purposes.
- `-p <host_port>:<container_port>` maps the port of the host (`80`) to a port of the container (`8000`).

- `myfastapiimage` is the name of the image from which the container is derived.

[Alternative to Step 4] Use Docker-compose

`docker-compose` is a tool ideal for defining and running multi-container Docker applications. With Compose, we use a `YAML file` (`.yml`)to configure the services of the application.

The biggest advantage of using `docker-compose` is that, with a single command, we create and start all the services from our configuration. You can read more about `docker-compose` ***here***.

Now let's see how we define the `docker-compose` in our case. Since ours is a single service application, defining the `docker-compose` should be fairly simple.

```yaml
version: "3.9"  # optional since v1.27.0
services:
  app:
    container_name: mycontainer
    build: .
    ports:
      - "8000:8000"
    volumes:
      - .:/src/

```

[fastapi_docker]docker-compose.yml hosted with ❤ by **GitHub** **view raw**

Explanations:

- This docker-compose has a single service called `app` defined.
- The `app` service uses an image that is built from the `Dockerfile` in the current directory.
- It then binds the container and the host machine to the exposed port, `8000`
- It also binds the `/src/` from the host to the container. The volume binding is necessary to reflect any change in the files on the host in the container.

Running `docker-compose` :

From the project directory, start up the application by running the following command.

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

Visit [***http://127.0.0.1:8000/***](http://127.0.0.1:8000/) from your browser to have the application up and running.

Some Handy Debugging Tips

- In case you’re facing problems with your image, you can try to get inside the container’s shell and debug it. To bash into the running container, type the following:

```
docker exec -t -i mycontainer /bin/bash
```

- In case your docker image fails to rebuild after changing the files, you can initiate a forced build as follows:

```
docker build --no-cache -t myfastapiimage .
```

- Sometimes, if you try re-running the docker container, you could get `container already in use` error. In that case, terminate the container, remove it by `docker rm <containerName>` and re-run your container. Or if you are using docker-compose, you can also type the following from the terminal (inside the project directory)

```
docker-compose down
```

- In case of `path errors`, be careful of the `container roots` you're using and adjust the paths accordingly.
- Also another handy docker command is the following:

```
docker ps -a
```

It provides you with all the list of all containers (running and stopped).

Conclusion

In this tutorial, we learnt how to containerise our application using `Docker`.

The next step after containerisation is deployment.
Once we are happy with the behaviour of our containerised application, we can deploy it on any managed/hybrid/on-premise cloud service with a minimised risk of failure.

Note: *this tutorial can be extended to any type of app containerisation and not only to FasAPI application.*
You just have to tweak the `Dockerfile` *and* `docker-compose` *accordingly. The rest remains the same* 😉.

✨ *The source code on GitHub can be accessed* ***here*****.**
The references and further readings on this topic have been summarised ***here****.*

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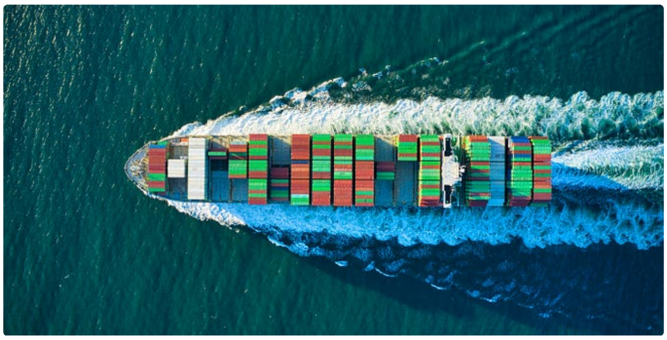

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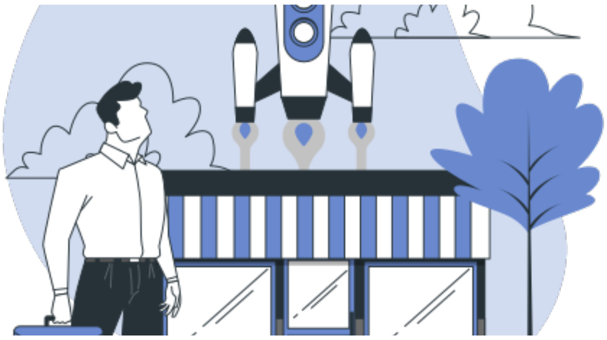

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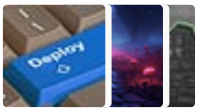

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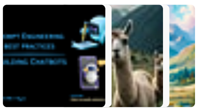

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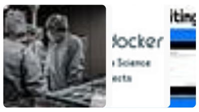

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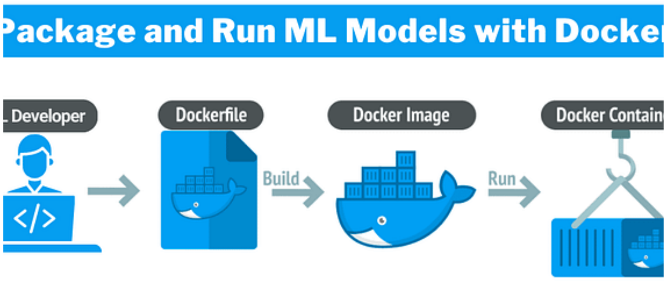

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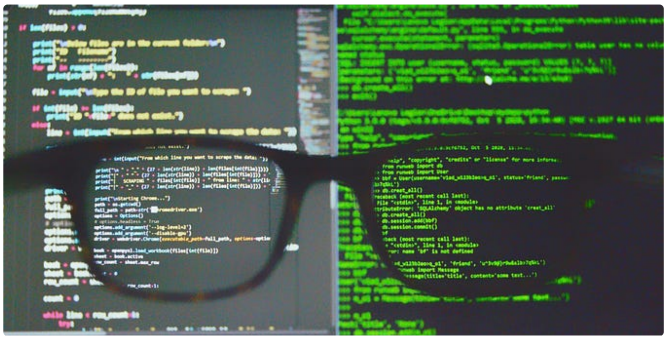

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