

Modelin Containerlaştırılması

İçerik:

- Dockerfile
- Image oluşturulması (Build the image)
- Container oluşumu (Run the image)
- Container içerisinde eğitim (train) ve test
- Container ve image silinmesi

Dosyalar: train.py, test.py, Dockerfile, requirements.txt, dataset.

train.py dosyasında oluşturulan modelin docker ile container haline getirilebilmesi için öncelikle dockerın bilgisayara kurulması gerekmektedir.

Kurulum için : <https://docs.docker.com/engine/install/>

1) Dockerfile

Container oluşturabilmesi için özellikleri (image) belirleyen dosyadır. Bu projede oluşturulan containerın içerisinde tensorflow ve requirements.txt dosyasında bulunan kütüphaneler (numpy vb.) hazır bulunur. Bunlarla birlikte “case-study-cicd-ml-jenkins” dosyası içerisinde (working directory) üzerinde çalışılan train.py, test.py, dataset, docs dosyaları bulunmaktadır. Dockerfile ile bir image oluşturulmaya başlandığında, bütün bu özellikler kurulum, train.py dosyası run edilir ve model oluşur.

2) Image oluşturulması (Build the image)

Image için verilen isim: docker-model

```
$ sudo docker build -t docker-model -f Dockerfile . (1)
```

```
zeynep@zeynep-Lenovo-ideapad-510-15IKB:~/git/workspace/case-study-cicd-ml-with-jenkins$ sudo docker build -t docker-model -f Dockerfile .
Sending build context to Docker daemon 41.04MB
Step 1/10 : FROM tensorflow/tensorflow
--> 94fcd0a37955e
Step 2/10 : WORKDIR /case-study-cicd-ml-with-jenkins
--> Running in b687616671f8
Removing intermediate container b687616671f8
--> ebsa71fda34c
Step 3/10 : RUN mkdir docs
--> Running in dee9a75821ee
Removing intermediate container dee9a75821ee
--> dcd0183056b2
Step 4/10 : COPY requirements.txt .
--> ee7075d9b495
Step 5/10 : RUN pip install -r requirements.txt
--> Running in 018c8a06691b
Requirement already satisfied: numpy in /usr/local/lib/python3.6/dist-packages (from -r requirements.txt (line 1)) (1.19.5)
Collecting matplotlib
  Downloading matplotlib-3.3.4-cp36-cp36m-manylinux1_x86_64.whl (11.5 MB)
Collecting pathlib
  Downloading pathlib-1.0.1.tar.gz (49 kB)
Collecting pyparsing<2.0.4,!=2.1.2,!=2.1.0,=>2.0.3
  Downloading pyparsing-2.4.7-py2.py3-none-any.whl (67 kB)
Collecting Kiwisolver<=1.0.1
  Downloading kiwisolver-1.3.1-cp36-cp36m-manylinux1_x86_64.whl (1.1 MB)
Collecting python-dateutil<=2.1
  Downloading python-dateutil-2.8.2-py2.py3-none-any.whl (247 kB)
Collecting pillow<=6.2.0
  Downloading Pillow-8.3.1-cp36-cp36m-manylinux_2_5_x86_64.manylinux1_x86_64.whl (3.0 MB)
Collecting cyclers<=0.10
  Downloading cyclers-0.10.0-py2.py3-none-any.whl (6.5 kB)
Requirement already satisfied: six<=1.5 in /usr/local/lib/python3.6/dist-packages (from python-dateutil<=2.1->matplotlib->-r requirements.txt (line 2)) (1.15.0)
Building wheels for collected packages: pathlib
  Building wheel for pathlib (setup.py): started
  Building wheel for pathlib (setup.py): finished with status 'done'
  Created wheel for pathlib: filename=pathlib-1.0.1-py3-none-any.whl size=14363 sha256=c7709071c3f1333ded4ce4cd1bc61602571d118dc609520686d403684b35cfd0
  Stored in directory: /root/.cache/pip/wheels/e1/32/91/afe2cabe6f77819de11759f2a07d538cd521ef3a9dd81ba0b4
Successfully built pathlib
Installing collected packages: pyparsing, kiwisolver, python-dateutil, pillow, cyclers, matplotlib, pathlib
Successfully installed cyclers-0.10.0 kiwisolver-1.3.1 matplotlib-3.3.4 pathlib-1.0.1 pillow-8.3.1 pyparsing-2.4.7 python-dateutil-2.8.2
WARNING: You are using pip version 20.2.4; however, version 21.2.4 is available.
You should consider upgrading via the '/usr/bin/python3 -m pip install --upgrade pip' command.
Removing intermediate container 018c8a06691b
--> e680439c5cec
Step 6/10 : COPY docs ./docs
--> 97c1b13164fb
Step 7/10 : COPY dataset ./dataset
--> f960853be014
Step 8/10 : COPY train.py ./train.py
--> 372cd5af1a80
Step 9/10 : COPY test.py ./test.py
--> 58c3b24848e
Step 10/10 : RUN python3 train.py
--> Running in be4137d23ebd
```

```

---> Running in be4137d23ebd
Your tensorflow version is : 2.6

1048
Found 4200 files belonging to 6 classes.
Found 1048 files belonging to 6 classes.
['cr', 'in', 'pa', 'ps', 'rs', 'sc']
Model: "sequential"

Layer (type)                 Output Shape                 Param #
=====
rescaling (Rescaling)        (None, 64, 64, 3)           0
conv2d (Conv2D)              (None, 64, 64, 16)          448
max_pooling2d (MaxPooling2D) (None, 32, 32, 16)          0
conv2d_1 (Conv2D)            (None, 32, 32, 32)          4640
max_pooling2d_1 (MaxPooling2 (None, 16, 16, 32)          0
dropout (Dropout)            (None, 16, 16, 32)          0
flatten (Flatten)            (None, 8192)                 0
dense (Dense)                (None, 128)                  1048704
dense_1 (Dense)              (None, 512)                  66048
dense_2 (Dense)              (None, 6)                    3078
=====
Total params: 1,122,918
Trainable params: 1,122,918
Non-trainable params: 0

Epoch 1/10
525/525 [=====] - 12s 21ms/step - loss: 1.2278 - accuracy: 0.4810 - val_loss: 1.2218 - val_accuracy: 0.5200
Epoch 2/10
525/525 [=====] - 11s 22ms/step - loss: 0.5303 - accuracy: 0.8060 - val_loss: 0.9394 - val_accuracy: 0.6365
Epoch 3/10
525/525 [=====] - 14s 27ms/step - loss: 0.2670 - accuracy: 0.9069 - val_loss: 0.4626 - val_accuracy: 0.8254
Epoch 4/10
525/525 [=====] - 13s 24ms/step - loss: 0.1576 - accuracy: 0.9421 - val_loss: 0.6162 - val_accuracy: 0.7653
Epoch 5/10
525/525 [=====] - 12s 22ms/step - loss: 0.1338 - accuracy: 0.9540 - val_loss: 0.8810 - val_accuracy: 0.6870
Epoch 6/10
525/525 [=====] - 12s 23ms/step - loss: 0.1161 - accuracy: 0.9621 - val_loss: 0.6036 - val_accuracy: 0.8502
Epoch 7/10
525/525 [=====] - 12s 24ms/step - loss: 0.0906 - accuracy: 0.9695 - val_loss: 0.9381 - val_accuracy: 0.7338
Epoch 8/10
525/525 [=====] - 13s 25ms/step - loss: 0.0681 - accuracy: 0.9767 - val_loss: 0.5077 - val_accuracy: 0.8378
Epoch 9/10
525/525 [=====] - 12s 22ms/step - loss: 0.0999 - accuracy: 0.9683 - val_loss: 0.6445 - val_accuracy: 0.7691
Epoch 10/10
525/525 [=====] - 10s 19ms/step - loss: 0.0767 - accuracy: 0.9745 - val_loss: 0.3332 - val_accuracy: 0.9027
Removing intermediate container be4137d23ebd
---> 0d64820d9978
Successfully built 0d64820d9978
Successfully tagged docker-model:latest

```

En sonda bulunan yazı ile image oluşumunun başarıyla tamamlandığını görebiliriz

Successfully built 0d64820d9978

Successfully tagged docker-model:latest

Aynı zamanda aşağıdaki komut ile var olan ve oluşturulan bütün imgeler görülebilir.

\$ sudo docker images (2)

```

zeynep@zeynep-Lenovo-ideapad-510-15IKB:~/git_workspace/case-study-cicd-ml-with-jenkins$ sudo docker images
REPOSITORY          TAG                 IMAGE ID            CREATED             SIZE
docker-model        latest             0d64820d9978       15 seconds ago     1.41GB
jupyter/scipy-notebook latest             ed86ff4a3e34       2 days ago         2.54GB
tensorflow/tensorflow latest             94fc08a3795e       2 weeks ago         1.32GB
hello-world         latest             d1165f221234       5 months ago       13.3kB

```

Yukarıdaki resimde de görüldüğü gibi Dockerfile ile oluşturulan “docker-model” image listesinde bulunmaktadır.

3) Container Oluşumu (Run the image)

Oluşturulan image aşağıdaki gibi run edildiğinde tek seferlik bir container oluşur. Ve image oluşturulurken eğitilen model, test edilir.

```
$ sudo docker run docker-model python3 test.py (3)
```

```
zeynepzeynep-Lenovo-Ideapad-510-15IKB:~/git_workspace/case-study-cicd-ml-with-jenkins$ sudo docker run docker-model python3 test.py
2021-09-01 13:32:22.862337: I tensorflow/core/platform/cpu_feature_guard.cc:142] This TensorFlow binary is optimized with oneAPI Deep Neural Network Library (oneDNN) to use the following CPU instructions
in performance-critical operations: AVX2 FMA
To enable them in other operations, rebuild TensorFlow with the appropriate compiler flags.
2021-09-01 13:32:23.796865: I tensorflow/compiler/mlir/mlir_graph_optimization_pass.cc:185] None of the MLIR Optimization Passes are enabled (registered 2)
1044
Found 1044 files belonging to 6 classes.
131/131 [=====] - 1s 7ms/step - loss: 0.2217 - accuracy: 0.9387
```

Container içerisine girip birden fazla işlem yapılabilir. (Ör: eğitim ve test tekrarı)

```
$ sudo docker run -i -t -p 8080:80 docker-model (4)
```

Container içerisinden çıkıldığında (çalışması bittiğinde) otomatik silinmesi isteniliyor ise “--rm” eklenebilir. Aynı durum (3) komutu için de geçerlidir.

```
$ sudo docker run --rm -i -t -p 8080:80 docker-model (5)
```

```
zeynep@zeynep-Lenovo-ideapad-510-15IKB:~/git_workspace/case-study-cicd-ml-with-jenkins$ sudo docker run -i -t -p 8080:80 docker-model

TensorFlow

WARNING: You are running this container as root, which can cause new files in
mounted volumes to be created as the root user on your host machine.

To avoid this, run the container by specifying your user's userid:

$ docker run -u $(id -u):$(id -g) args...

root@31d534d13a4b:/case-study-cicd-ml-with-jenkins# ls
dataset  docs  'model artifact'  requirements.txt  test.py  train.py
```

Yukarıdaki resimde container içerisine girilmiştir:

- root@31d534d13a4b:/case-study-cicd-ml-with-jenkins#

Container id: 31d534d13a4b

Working directory : case-study-cicd-ml-with-jenkins

Working directory içerisinde ls komutuyla görülen dosyalar:

- dataset docs 'model artifact' requirements.txt test.py train.py

Örnek:

Tekrardan “python3 train.py” komutu ile tekrar eğitim yapılabilir ve “python3 test.py” ile test edilebilir.

```
root@31d534d13a4b:/case-study-cicd-ml-with-jenkins# python3 train.py
Your tensorflow version is : 2.6

1048
Found 4200 files belonging to 6 classes.
Found 1048 files belonging to 6 classes.
['cr', 'in', 'pa', 'ps', 'rs', 'sc']
Model: "sequential"

Layer (type)                 Output Shape                 Param #
=====
rescaling (Rescaling)        (None, 64, 64, 3)           0
conv2d (Conv2D)              (None, 64, 64, 16)          448
max_pooling2d (MaxPooling2D) (None, 32, 32, 16)           0
conv2d_1 (Conv2D)            (None, 32, 32, 32)          4640
max_pooling2d_1 (MaxPooling2 (None, 16, 16, 32)           0
dropout (Dropout)            (None, 16, 16, 32)           0
flatten (Flatten)            (None, 8192)                 0
dense (Dense)                (None, 128)                  1048704
dense_1 (Dense)              (None, 512)                  66048
dense_2 (Dense)              (None, 6)                    3078
=====
Total params: 1,122,918
Trainable params: 1,122,918
Non-trainable params: 0

Epoch 1/10
525/525 [=====] - 13s 24ms/step - loss: 1.0060 - accuracy: 0.5683 - val_loss: 0.9053 - val_accuracy: 0.5067
Epoch 2/10
525/525 [=====] - 11s 20ms/step - loss: 0.4570 - accuracy: 0.8298 - val_loss: 0.7420 - val_accuracy: 0.6994
Epoch 3/10
525/525 [=====] - 11s 20ms/step - loss: 0.2979 - accuracy: 0.9012 - val_loss: 0.4909 - val_accuracy: 0.8387
Epoch 4/10
525/525 [=====] - 11s 22ms/step - loss: 0.2048 - accuracy: 0.9274 - val_loss: 0.5421 - val_accuracy: 0.8111
Epoch 5/10
525/525 [=====] - 11s 22ms/step - loss: 0.1567 - accuracy: 0.9457 - val_loss: 0.9936 - val_accuracy: 0.6345
Epoch 6/10
525/525 [=====] - 12s 22ms/step - loss: 0.1623 - accuracy: 0.9455 - val_loss: 0.5876 - val_accuracy: 0.7824
Epoch 7/10
525/525 [=====] - 12s 22ms/step - loss: 0.1331 - accuracy: 0.9533 - val_loss: 0.3336 - val_accuracy: 0.8807
Epoch 8/10
525/525 [=====] - 12s 22ms/step - loss: 0.1006 - accuracy: 0.9662 - val_loss: 0.1836 - val_accuracy: 0.9485
Epoch 9/10
525/525 [=====] - 14s 26ms/step - loss: 0.1162 - accuracy: 0.9600 - val_loss: 0.3884 - val_accuracy: 0.8454
Epoch 10/10

root@31d534d13a4b:/case-study-cicd-ml-with-jenkins# python3 test.py
2021-09-01 15:01:20.560728: I tensorflow/core/platform/cpu_feature_guard.cc:142] This TensorFlow binary is optimized with oneAPI Deep Neural Network Library (oneDNN) to use the following CPU instructions
in performance-critical operations: AVX2 FMA
To enable them in other operations, rebuild TensorFlow with the appropriate compiler flags.
1044
Found 1044 files belonging to 6 classes.
2021-09-01 15:01:27.435289: I tensorflow/compiler/mlir/mlir_graph_optimization_pass.cc:185] None of the MLIR Optimization Passes are enabled (registered 2)
131/131 [=====] - 1s 7ms/step - loss: 0.2609 - accuracy: 0.9128
```

Container içerisinde her bir eğitimin (12 kere), yeni veriler ile test edilmesi sonucu oluşan doğruluk yüzdeleri:

- loss: 0.2479 - accuracy: 0.9176
- loss: 0.4099 - accuracy: 0.8745
- loss: 0.1615 - accuracy: 0.9492
- loss: 0.2609 - accuracy: 0.9128
- loss: 0.4220 - accuracy: 0.8649
- loss: 0.3565 - accuracy: 0.8649
- loss: 0.1011 - accuracy: 0.9693
- loss: 0.2416 - accuracy: 0.9157
- loss: 0.2577 - accuracy: 0.9033
- loss: 0.3818 - accuracy: 0.8697
- loss: 0.2576 - accuracy: 0.9061
- loss: 0.2040 - accuracy: 0.9282

Classes: ['cr', 'in', 'pa', 'ps', 'rs', 'sc']

4200 files for training belonging to 6 classes.

1048 files for validation belonging to 6 classes.

Container içerisinden çıkış yapmak için ctrl+d basılır ve exit yazısı görülür.

Çalışır durumda olan olan container listesini görebilmek için:

```
$ sudo docker container ls (6)
```

Var olan tüm (çalışır durumda ya da durmuş) containerların listesini görebilmek için:
(--rm ile çalıştırıldıysa silinmiştir.)

```
$ sudo docker container ls -a (7)
```

```
zeynep@zeynep-Lenovo-ideapad-510-15IKB:~/git_workspace/case-study-cicd-ml-with-jenkins$ sudo docker container ls -a
CONTAINER ID   IMAGE          COMMAND        CREATED        STATUS        PORTS        NAMES
31d534d13a4b   docker-model   "bash"        3 hours ago    Exited (0)    2 minutes ago    quirky_swartz
8587ab493dd4   hello-world    "/hello"      2 days ago    Exited (0)    2 days ago    reverent_darwin
```

4) Container ve Image Silinmesi (Remove)

Image her run edildiğinde yeni bir container oluştuğu için, iş bittikten sonra container çalışması durdurulup silinmesi gerekir.

Container ve image isim veya id numarası ile silinebilir.

Container durdurulması:

```
$ sudo docker container stop container-id (8)
```

Container silinmesi:

```
$ sudo docker rm container-id (9)
```

```
zeynep@zeynep-Lenovo-ideapad-510-15IKB:~/git_workspace/case-study-cicd-ml-with-jenkins$ sudo docker stop 31d534d13a4b
zeynep@zeynep-Lenovo-ideapad-510-15IKB:~/git_workspace/case-study-cicd-ml-with-jenkins$ sudo docker rm 31d534d13a4b
zeynep@zeynep-Lenovo-ideapad-510-15IKB:~/git_workspace/case-study-cicd-ml-with-jenkins$ sudo docker container ls -a
CONTAINER ID   IMAGE          COMMAND        CREATED        STATUS        PORTS        NAMES
8587ab493dd4   hello-world    "/hello"      2 days ago    Exited (0)    2 days ago    reverent_darwin
```

Image silinmesi:

```
$ sudo docker rmi model-name (10)
```

Not: Var olan bir image, onu kullanan bütün containerlar kaldırılana kadar silinemez. Aynı image başka container tarafından kullanılıyor olabilir. Dolayısıyla öncelikle oluşturulan container silinmelidir. Bu tip bir problemle karşılaşmamak için container oluşturulurken (image run edilirken) “--rm” komutu eklenebilir. (5) numaralı komut buna bir örnektir. --rm, iş bittikten sonra containerı otomatik siler.