03_experiments

October 26, 2025

[1]:
```
import sys
import os

# Add root directory of rhe project into sys.path
sys.path.append("/kaggle/input/license-plate-module")
```

0.1 0. Libraries

[2]:
```
from src.visualization import display_images_and_targets
from src.data_preprocessing import download_dataset, preprocess_data
from src.dataset import LicensePlateDataset
from src.model import FTFasterRCNN
from src.train import train_model
from src.evaluate import evaluate_model
from src.callbacks import EarlyStopping, ModelCheckpoints
from src.config import (
    RAW_DATA_DIR,
    PROCESSED_DATA_DIR,
    IMAGE_SIZE,
    MEAN_NORMALIZATION,
    STD_NORMALIZATION,
    NUM_WORKERS,
    BATCH_SIZE,
    NUM_CLASSES,
    DEVICE,
    EPOCHES,
    LEARNING_RATE,
    WEIGHT_DECAY,
    MOMENTUM,
    STEP_SIZE,
    GAMMA
)

from torchvision import transforms
from torch.utils.data import DataLoader
from torch.optim import SGD
from torch.optim.lr_scheduler import StepLR
```

```
import torchinfo

import warnings
warnings.filterwarnings("ignore")
```

0.2 1. Dataset

[3]:
```
# Download dataset from Github
download_dataset(dest=RAW_DATA_DIR)
```

```
Dataset does not exist, please waiting to download data from the cloud…
Start to download…
0/20 of data are downloaded
5/20 of data are downloaded
10/20 of data are downloaded
15/20 of data are downloaded

license-plate-project.zip: 100%|      | 965M/965M [00:11<00:00, 89.1MB/s]

Downloaded, please waiting to extract file…
Extracting…
Extracted!!
Removing zip file…
Removed!!
Done!!
```

[4]:
```
# Data preprocessing
preprocess_data(RAW_DATA_DIR, PROCESSED_DATA_DIR, IMAGE_SIZE)
```

```
Preprocessing data in test folder…: 100%|      | 978/978 [00:02<00:00,
380.38it/s]
Preprocessing data in valid folder…: 100%|      | 1973/1973 [00:05<00:00,
380.00it/s]
Preprocessing data in train folder…: 100%|      | 20580/20580
[00:52<00:00, 390.53it/s]
```

[5]:
```
# Get the list of file paths in each folder
file_pathes = {}
for dir_name in os.listdir(PROCESSED_DATA_DIR):
    dir_path = os.path.join(PROCESSED_DATA_DIR, dir_name)
    file_pathes[dir_name] = []
    for filename in os.listdir(dir_path):
        file_pathes[dir_name].append(os.path.join(dir_path, filename))
```

[6]:
```
def collate_fn(batch):
    """
    Custom collate function to handle batches with varying number of bounding␣
 ↪boxes.
    """
```

```
    images, targets = zip(*batch)
    images = list(images)  # Keep images as a list
    targets = list(targets)  # Keep targets as a list of dictionaries
    return images, targets
```

[7]:
```
# Transform images
transform = transforms.Compose([
    transforms.Resize(IMAGE_SIZE),
    transforms.ToTensor(),
    transforms.Normalize(mean=MEAN_NORMALIZATION, std=STD_NORMALIZATION)
])

# Declare dataset and dataloader
train_dataset = LicensePlateDataset(file_paths=file_pathes["train"],␣
 ↪transform=transform)
valid_dataset = LicensePlateDataset(file_paths=file_pathes["valid"],␣
 ↪transform=transform)
test_dataset = LicensePlateDataset(file_paths=file_pathes["test"],␣
 ↪transform=transform)

# Split dataset to batches
train_dataloader = DataLoader(
    dataset=train_dataset,
    batch_size=BATCH_SIZE,
    num_workers=NUM_WORKERS,
    persistent_workers=True,
    pin_memory=True,
    shuffle=True,
    prefetch_factor=10,
    collate_fn=collate_fn
)

valid_dataloader = DataLoader(
    dataset=valid_dataset,
    batch_size=BATCH_SIZE,
    num_workers=NUM_WORKERS,
    persistent_workers=True,
    pin_memory=True,
    shuffle=True,
    prefetch_factor=10,
    collate_fn=collate_fn
)

test_dataloader = DataLoader(
    dataset=test_dataset,
    batch_size=BATCH_SIZE,
    num_workers=NUM_WORKERS,
```

```
    persistent_workers=True,
    pin_memory=True,
    shuffle=True,
    prefetch_factor=10,
    collate_fn=collate_fn
)
```

0.3 2. Faster RCNN model

[9]:
```
faster_rcnn_model = FTFasterRCNN(num_classes=NUM_CLASSES, freeze_backbone=True)
faster_rcnn_model.to(DEVICE)
torchinfo.summary(faster_rcnn_model, (3, IMAGE_SIZE[0], IMAGE_SIZE[1]),␣
 ↪batch_dim=0, depth=3)
```

```
Downloading: "https://download.pytorch.org/models/resnet50-11ad3fa6.pth" to
/root/.cache/torch/hub/checkpoints/resnet50-11ad3fa6.pth
100%|      | 97.8M/97.8M [00:06<00:00, 15.0MB/s]
```

[9]:
```
==========================================================================================
==========================
Layer (type:depth-idx)                                  Output Shape
Param #
==========================================================================================
==========================
FTFasterRCNN                                            [1, 4]
--
 FasterRCNN: 1-1                                        [1, 4]
--
      GeneralizedRCNNTransform: 2-1                     [1, 3, 800, 800]
--
      Sequential: 2-2                                   [1, 1024, 50, 50]
--
           Conv2d: 3-1                                  [1, 64, 400, 400]
(9,408)
           BatchNorm2d: 3-2                             [1, 64, 400, 400]
(128)
           ReLU: 3-3                                    [1, 64, 400, 400]
--
           MaxPool2d: 3-4                               [1, 64, 200, 200]
--
           Sequential: 3-5                              [1, 256, 200, 200]
(215,808)
           Sequential: 3-6                              [1, 512, 100, 100]
(1,219,584)
           Sequential: 3-7                              [1, 1024, 50, 50]
7,098,368
      RegionProposalNetwork: 2-3                        [1, 4]
--
```

```
          RPNHead: 3-8                                [1, 15, 50, 50]
9,515,083
          AnchorGenerator: 3-9                        [1, 4]
--
      RoIHeads: 2-4                                    [1, 4]
--
          MultiScaleRoIAlign: 3-10                    [1000, 1024, 7, 7]
--
          TwoMLPHead: 3-11                            [1000, 1024]
52,430,848
          FastRCNNPredictor: 3-12                     [1, 2]
10,250
==========================================================================
========================
Total params: 70,499,477
Trainable params: 69,054,549
Non-trainable params: 1,444,928
Total mult-adds (G): 118.04
==========================================================================
========================
Input size (MB): 0.60
Forward/backward pass size (MB): 2178.60
Params size (MB): 282.00
Estimated Total Size (MB): 2461.20
==========================================================================
========================
```

[10]:
```
optimizer = SGD(
    filter(lambda p: p.requires_grad, faster_rcnn_model.parameters()),
    lr=LEARNING_RATE,
    momentum=MOMENTUM,
    weight_decay=WEIGHT_DECAY
)
lr_scheduler = StepLR(
        optimizer=optimizer,
        step_size=STEP_SIZE,
        gamma=GAMMA
    )
early_stopping = EarlyStopping(patience=10)
model_checkpoints = ModelCheckpoints("faster_rcnn_checkpoints.pt")
```

[ ]:
```
faster_rcnn_history = train_model(
                        model=faster_rcnn_model,
                        train_dataloader=train_dataloader,
                        epoches=EPOCHES,
                        optimizer=optimizer,
                        lr_scheduler=lr_scheduler,
```

```
                        valid_dataloader=valid_dataloader,
                        early_stopping=early_stopping,
                        model_checkpoint=model_checkpoints
                )
```

```
Epoch 1/30: 100%|      | 1286/1286 [22:54<00:00,  1.07s/it, loss=0.286]
Validation set: Average loss: 0.2448 - Accuracy: 2854/9018 (31.65%)

Epoch 2/30: 100%|      | 1286/1286 [20:09<00:00,  1.06it/s, loss=0.257]
Validation set: Average loss: 0.2021 - Accuracy: 2286/6202 (36.86%)

Epoch 3/30: 100%|      | 1286/1286 [20:53<00:00,  1.03it/s, loss=0.221]
Validation set: Average loss: 0.1825 - Accuracy: 2098/4509 (46.53%)

Epoch 4/30: 100%|      | 1286/1286 [21:26<00:00,  1.00s/it, loss=0.2]
Validation set: Average loss: 0.1723 - Accuracy: 2076/4104 (50.58%)

Epoch 5/30: 100%|      | 1286/1286 [21:42<00:00,  1.01s/it, loss=0.189]
Validation set: Average loss: 0.1583 - Accuracy: 2101/4216 (49.83%)

Epoch 6/30: 100%|      | 1286/1286 [22:12<00:00,  1.04s/it, loss=0.177]
Validation set: Average loss: 0.1587 - Accuracy: 2078/3705 (56.09%)

Epoch 7/30: 100%|      | 1286/1286 [22:21<00:00,  1.04s/it, loss=0.171]
Validation set: Average loss: 0.1449 - Accuracy: 2082/3694 (56.36%)

Epoch 8/30: 100%|      | 1286/1286 [22:54<00:00,  1.07s/it, loss=0.162]
Validation set: Average loss: 0.1374 - Accuracy: 2048/3458 (59.22%)

Epoch 9/30: 100%|      | 1286/1286 [23:08<00:00,  1.08s/it, loss=0.156]
Validation set: Average loss: 0.1447 - Accuracy: 2043/3495 (58.45%)

Epoch 10/30: 100%|     | 1286/1286 [23:15<00:00,  1.08s/it, loss=0.153]
Validation set: Average loss: 0.1407 - Accuracy: 2058/3413 (60.30%)

Epoch 11/30: 100%|     | 1286/1286 [22:52<00:00,  1.07s/it, loss=0.152]
```

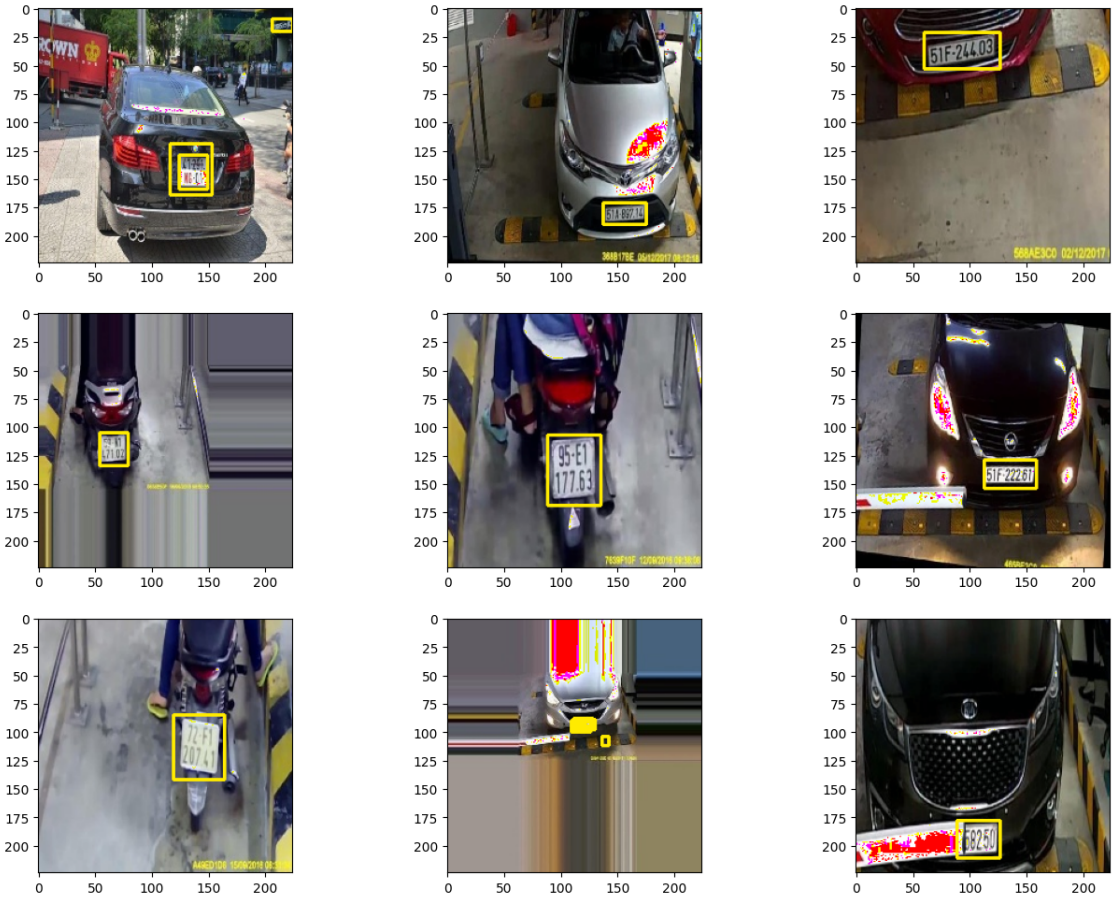
```
Validation set: Average loss: 0.1340 - Accuracy: 2010/3165 (63.51%)

Epoch 12/30: 100%|      | 1286/1286 [23:08<00:00,  1.08s/it, loss=0.149]
Validation set: Average loss: 0.1326 - Accuracy: 2017/3147 (64.09%)

Epoch 13/30: 100%|      | 1286/1286 [23:16<00:00,  1.09s/it, loss=0.148]
Validation set: Average loss: 0.1339 - Accuracy: 2014/3113 (64.70%)

Epoch 14/30: 100%|      | 1286/1286 [23:06<00:00,  1.08s/it, loss=0.149]
Validation set: Average loss: 0.1302 - Accuracy: 2016/3153 (63.94%)

Epoch 15/30: 100%|      | 1286/1286 [23:10<00:00,  1.08s/it, loss=0.148]
Validation set: Average loss: 0.1306 - Accuracy: 2032/3215 (63.20%)

Epoch 16/30: 100%|      | 1286/1286 [23:22<00:00,  1.09s/it, loss=0.147]
Validation set: Average loss: 0.1316 - Accuracy: 2029/3220 (63.01%)

Epoch 17/30: 100%|      | 1286/1286 [23:14<00:00,  1.08s/it, loss=0.148]
Validation set: Average loss: 0.1314 - Accuracy: 2012/3174 (63.39%)

Epoch 18/30: 100%|      | 1286/1286 [23:20<00:00,  1.09s/it, loss=0.147]
Validation set: Average loss: 0.1337 - Accuracy: 2018/3231 (62.46%)

Epoch 19/30: 100%|      | 1286/1286 [23:11<00:00,  1.08s/it, loss=0.148]
Validation set: Average loss: 0.1313 - Accuracy: 2023/3242 (62.40%)

Epoch 20/30: 100%|      | 1286/1286 [23:16<00:00,  1.09s/it, loss=0.147]
Validation set: Average loss: 0.1328 - Accuracy: 2011/3168 (63.48%)

Epoch 21/30: 100%|      | 1286/1286 [23:06<00:00,  1.08s/it, loss=0.148]
Validation set: Average loss: 0.1324 - Accuracy: 2008/3135 (64.05%)

Epoch 22/30: 100%|      | 1286/1286 [23:07<00:00,  1.08s/it, loss=0.148]
Validation set: Average loss: 0.1321 - Accuracy: 2013/3152 (63.86%)

Epoch 23/30: 100%|      | 1286/1286 [23:10<00:00,  1.08s/it, loss=0.147]
```

```
Validation set: Average loss: 0.1316 - Accuracy: 2017/3188 (63.27%)

Epoch 24/30: 100%|      | 1286/1286 [23:12<00:00,  1.08s/it, loss=0.147]
Validation set: Average loss: 0.1324 - Accuracy: 2017/3179 (63.45%)

Epoch 25/30: 100%|      | 1286/1286 [23:11<00:00,  1.08s/it, loss=0.147]
Validation set: Average loss: 0.1312 - Accuracy: 2024/3154 (64.17%)

Epoch 26/30:  30%|         | 391/1286 [07:03<16:10,  1.08s/it, loss=0.147]
```

[8]:
```
test_images, test_targets, test_predictions = evaluate_model(
    "/kaggle/input/faster-rcnn/pytorch/faster-rcnn-resnet34/1/
 ↪best_faster_rcnn_checkpoints.pt",
    test_dataloader
)
```

```
Downloading: "https://download.pytorch.org/models/resnet50-11ad3fa6.pth" to
/root/.cache/torch/hub/checkpoints/resnet50-11ad3fa6.pth
100%|      | 97.8M/97.8M [00:00<00:00, 192MB/s]

Average IoU: 0.5763925313949585
Predicted: 1021/1556
Percentage of predictions with IoU > 0.5: 65.6169662475586 %
```

[10]:
```
display_images_and_targets(test_images, test_predictions)
```


51F-244.03
95-E1
177.63
51F-222.67
92-F1
207.41
382.50