

```
In [1]: ! pip install --quiet \  
"setuptools==59.5.0" \  
"pytorch-lightning>=1.4" \  
"matplotlib" "torch>=1.8" \  
"ipython[notebook]" \  
"torchmetrics>=0.7" \  
"torchvision" \  
"seaborn" \  
"opencv-python"
```

```
In [2]: !pip install --quiet nbconvert[webpdf]  
--allow-chromium-download
```

```
-----  
NameError                                Traceback (most recent call last)  
/var/folders/np/70fb848925g8grcrpmx4jxpw0000gn/T/ipykernel_1228/2152819344.  
py in <module>  
      1 get_ipython().system('pip install --quiet nbconvert[webpdf]')  
----> 2 --allow-chromium-download  
  
NameError: name 'allow' is not defined
```

```
In [114... import pandas as pd  
import numpy as np  
import matplotlib.pyplot as plt  
%matplotlib inline  
import cv2  
import os  
import torch  
from torchvision import transforms  
from torch.utils.data import Dataset, DataLoader  
import torchvision  
import string  
from torchmetrics import CharErrorRate  
import torch.nn.functional as F
```

```
In [ ]: def accuracy(preds, target):  
    N = len(preds)  
    accurate = 0  
    for i in range(len(preds)):  
        if preds[i] == target[i]:  
            accurate += 1  
    return accurate/N
```

Соберем все символы, которые могут встретиться в датасете для последующего кодирования

```
In [182... #Провинции в Китае, иероглифы которых могут встретиться на автомобильных ном  
dict_provinces = {  
    '粤': 'Гуандун',  
    '黑': 'Хэйлунцзян',  
    '蒙': 'Автономный район Внутренняя Монголия',  
    '琼': 'Хайнань',
```

```

'辽': 'Ляонин',
'鲁': 'Шаньдун',
'贵': 'Фуцзянь',
'浙': 'Чжецзян',
'新': 'Синьцзян-Уйгурский Автономный Район',
'吉': 'Провинция Цзилинь',
'皖': 'Аньхой',
'甘': 'Ганьсу',
'闽': 'Гуйчжоу',
'冀': 'Хэбэй',
'豫': 'Хэнань',
'鄂': 'Хубэй',
'湘': 'Хунань',
'苏': 'Цзянсу',
'赣': 'Цзянси',
'青': 'Цинхай',
'陕': 'Шэньси',
'晋': 'Шаньси',
'川': 'Сычуань',
'云': 'Юньнань',
'桂': 'Гуанси-Чжуанский Автономный Округ',
'宁': 'Нинся-Хуэйский Автономный Округ',
'藏': 'Автономный Округ Тибет',
'京': 'Beijing',
'渝': 'Chongqing',
'沪': 'Shanghai',
'津': 'Tianjin'
}

```

```

NUMBER = list(string.digits)
ALPHABET = list(string.ascii_uppercase)
Hieroglyphics = list(dict_provinces.keys())
ALL_CHAR_SET = NUMBER + ALPHABET + Hieroglyphics
ALL_CHAR_SET_LEN = len(ALL_CHAR_SET)

```

```
In [183... ALL_CHAR_SET_LEN, len(Hieroglyphics)
```

```
Out[183]: (67, 31)
```

```
In [184... data_path = '/Users/alenabuk/Downloads/CCPD2019-dl1'
```

```

In [188... #Загрузим для примера картинку из train
img = cv2.imread(data_path + '/train/01-皖A5M877.jpg')
print(img.shape)
plt.imshow(img)

```

```
(62, 181, 3)
```

```
Out[188]: <matplotlib.image.AxesImage at 0x7f94139c8eb0>
```



```
In [189... #определим размеры картинок в train
cnt, mean_h, mean_w = 0, 0, 0
for i in os.listdir(data_path + '/train'):
    img = cv2.imread(data_path + '/train/' + f'{i}')

    if cnt == 0:
        min_shape_h, max_shape_h = img.shape[0], img.shape[0]
        min_shape_w, max_shape_w = img.shape[1], img.shape[1]

    if img.shape[0] > max_shape_h:
        max_shape_h = img.shape[0]
        max_img_h = img
    if img.shape[0] < min_shape_h:
        min_shape_h = img.shape[0]
        min_img_h = img

    if img.shape[1] > max_shape_w:
        max_shape_w = img.shape[1]
        max_img_w = img
    if img.shape[1] < min_shape_w:
        min_shape_w = img.shape[1]
        min_img_w = img

    h, w = img.shape[0], img.shape[1]

    mean_h = ((mean_h * cnt) + h)/(cnt + 1)
    mean_w = ((mean_w * cnt) + w)/(cnt + 1)
    cnt += 1
```

```
In [190... # (наименьший, наибольший, средний) по высоте размер картинки
min_shape_h, max_shape_h, mean_h
```

```
Out[190]: (28, 239, 84.81559155915525)
```

```
In [191... # (наименьший, наибольший, средний) по ширине размер картинки
min_shape_w, max_shape_w, mean_w
```

```
Out[191]: (74, 719, 249.84530453045298)
```

```
In [192... #картинка с наибольшим значением по высоте
max_img_h.shape
```

```
Out[192]: (239, 692, 3)
```

```
In [193... #картинка с наибольшим значением по ширине
```

```
max_img_w.shape
```

Out[193]: (211, 719, 3)

```
In [194... #Посмотрим на самую высокую картинку  
plt.imshow(transforms.ToPILImage()(transforms.ToTensor()(max_img_h)), interp
```

Out[194]: <matplotlib.image.AxesImage at 0x7f94175a4580>



```
In [195... #Та же картинка после приведения к наименьшим в train датасете параметрам  
plt.imshow(transforms.ToPILImage()(transforms.Resize((28, 74))(transforms.To
```

Out[195]: <matplotlib.image.AxesImage at 0x7f9406799be0>



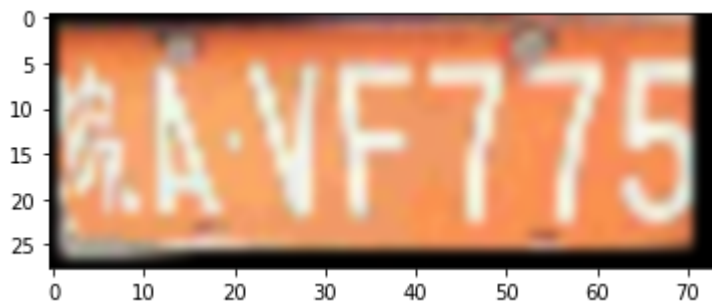
```
In [196... #Посмотрим на самую широкую картинку  
plt.imshow(transforms.ToPILImage()(transforms.ToTensor()(max_img_w)), interp
```

Out[196]: <matplotlib.image.AxesImage at 0x7f93fd6868b0>



```
In [197... #Та же картинка после приведения к наименьшим в train датасете параметрам  
plt.imshow(transforms.ToPILImage()(transforms.Resize((28, 74))(transforms.To
```

Out[197]: <matplotlib.image.AxesImage at 0x7f9405a7a130>

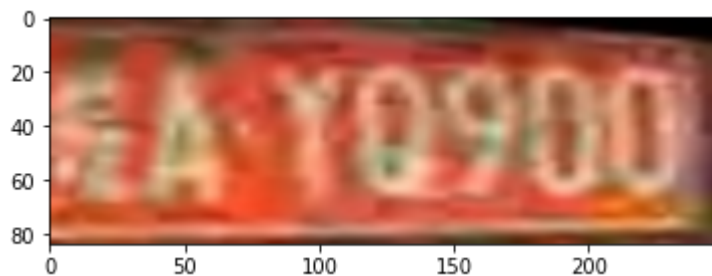


```
In [198... #Посмотрим на самую маленькую по ширине картинку
transforms.ToPILImage()(min_img_w)
```

```
Out[198]:
```

```
In [199... #Та же картинка после приведения к средним в train датасете параметрам
plt.imshow(transforms.ToPILImage()(transforms.Resize((84, 249))(transforms.T
interpolation="bicubic"))
```

```
Out[199]: <matplotlib.image.AxesImage at 0x7f94128bab20>
```



Лучше приводить к наименьшим размерам, так как даже самые высокие и широкие картинки несильно теряют в качестве по сравнению с растяжением

В качестве дефолтных трансформаций будем использовать `ToTensor()` и `Resize((28, 74))`

```
In [201... max_img_w.shape
```

```
Out[201]: (211, 719, 3)
```

```
In [202... transforms.ToTensor()(max_img_w).shape
```

```
Out[202]: torch.Size([3, 211, 719])
```

```
In [203... transforms.Resize((28, 74))(transforms.ToTensor()(max_img_w)).shape
```

```
Out[203]: torch.Size([3, 28, 74])
```

```
In [204... #Кодировщик лейблов в разреженный вектор
def encode(a):
    onehot = [0]*ALL_CHAR_SET_LEN
    idx = ALL_CHAR_SET.index(a)
```

```

onehot[idx] += 1
return onehot

```

```

In [216... class PlateDetDataset(Dataset):
    def __init__(self, path=None, train=False,
                 transform=transforms.Compose([transforms.ToTensor(), transf
                 ]):
        super(Dataset, self).__init__()
        self.transform = transform
        self.train = train
        if path is None:
            return 'No path to file'
        else:
            self.data_path = path

            if self.train:
                self.train_file_names = [p for p in os.listdir(self.data_path)
                self.train_labels = [p.split('-')[1].split('.')[0] for p in

            else:
                self.test_file_names = [p for p in os.listdir(self.data_path)
                self.test_labels = [p.split('-')[1].split('.')[0] for p in s

    def __len__(self):
        if self.train:
            return len(self.train_file_names)
        else:
            return len(self.test_file_names)

    def __getitem__(self, index):
        if self.train:
            self.label_train_en = []

            for i in self.train_labels[index]:
                self.label_train_en += encode(i)

            return self.transform(cv2.imread(self.data_path + '/train/' + self.train_file_names[index]), \
                np.array(self.label_train_en), \
                self.train_labels[index])

        else:
            self.label_test_en = []

            for i in self.test_labels[index]:
                self.label_test_en += encode(i)

            return self.transform(cv2.imread(self.data_path + '/test/' + self.test_file_names[index]), \
                np.array(self.label_test_en), \
                self.test_labels[index])

```

In [318... *#Сделаем dataloaders*

```

train_dataset = PlateDetDataset(path=data_path, train=True)
data_train, data_val = torch.utils.data.random_split(
    PlateDetDataset(path=data_path, train=True),

```



```

torch.nn.init.constant_(self.batch_norm.weight, 0.5)
torch.nn.init.zeros_(self.batch_norm.bias)

```

```

def forward(self, x):
    out = self.conv(x)
    out = self.batch_norm(out)
    out = torch.relu(out)
    return out + x

```

```

In [379]: class NetResDeep(nn.Module):
def __init__(self, n_chans1=64, n_blocks=10):
    super().__init__()
    self.n_chans1 = n_chans1
    self.conv1 = nn.Conv2d(3, 64, kernel_size=(7, 7), stride=(2, 2), padding=1)
    self.resblocks = nn.Sequential(
        *(n_blocks * [ResBlock(n_chans=n_chans1)]))
    self.fc1 = nn.Linear(64 * 3 * 9, 512)
    self.fc = nn.Linear(in_features=512, out_features=ALL_CHAR_SET_LEN*MAX_LEN)

def forward(self, x):
    out = F.max_pool2d(torch.relu(self.conv1(x)), 2)
    out = self.resblocks(out)
    out = F.max_pool2d(out, 2)
    out = out.view(-1, 64 * 3 * 9)
    out = torch.relu(self.fc1(out))
    out = self.fc(out)
    return out

```

```

In [380]: #Проверим вывод для одной картинки
x = transforms.Resize((28, 74))(transforms.ToTensor()(max_img_h))
NetResDeep().forward(x.unsqueeze(0)).shape

```

```

Out[380]: torch.Size([1, 469])

```

```

In [382]: from torchvision import models
import torch.nn as nn
# from fastai.vision import Path
import torch
from torch.autograd import Variable

MAX_LEN = 7 #число символов на картинке

# model = models.resnet18(pretrained=False)
# model.conv1 = nn.Conv2d(3, 64, kernel_size=(7, 7), stride=(2, 2), padding=1)
# model.fc = nn.Linear(in_features=512, out_features=ALL_CHAR_SET_LEN*MAX_LEN)
model = NetResDeep(n_blocks=100)
loss_func = nn.MultiLabelSoftMarginLoss()
optim = torch.optim.Adam(model.parameters(), lr=0.001)

#Обучение модели
#Очень долго считается без gru, поэтому стоит 1 эпоха
cnt_new = 0
for epoch in range(1):
    for step, i in enumerate(data_train_loader):
        img, label Oh, label = i

```



```
img = Variable(img)
label_oh = Variable(label_oh.float())
pred = model(img)
loss = loss_func(pred, label_oh)
optm.zero_grad()
loss.backward()
optm.step()
print('epoch:', epoch+1, 'step:', step+1, 'loss:', loss.item())
```

epoch: 1 step: 1 loss: 5.2739644050598145
epoch: 1 step: 2 loss: 2.0927109718322754
epoch: 1 step: 3 loss: 0.7895427346229553
epoch: 1 step: 4 loss: 0.3862074613571167
epoch: 1 step: 5 loss: 0.26654505729675293
epoch: 1 step: 6 loss: 0.23883454501628876
epoch: 1 step: 7 loss: 0.21945947408676147
epoch: 1 step: 8 loss: 0.1967751383781433
epoch: 1 step: 9 loss: 0.18641474843025208
epoch: 1 step: 10 loss: 0.19721664488315582
epoch: 1 step: 11 loss: 0.1918654590845108
epoch: 1 step: 12 loss: 0.1688743680715561
epoch: 1 step: 13 loss: 0.15318095684051514
epoch: 1 step: 14 loss: 0.13998320698738098
epoch: 1 step: 15 loss: 0.15275058150291443
epoch: 1 step: 16 loss: 0.14118629693984985
epoch: 1 step: 17 loss: 0.13254036009311676
epoch: 1 step: 18 loss: 0.1279297024011612
epoch: 1 step: 19 loss: 0.12145790457725525
epoch: 1 step: 20 loss: 0.1053079143166542
epoch: 1 step: 21 loss: 0.1011512503027916
epoch: 1 step: 22 loss: 0.10100069642066956
epoch: 1 step: 23 loss: 0.0855431854724884
epoch: 1 step: 24 loss: 0.09172966331243515
epoch: 1 step: 25 loss: 0.08134917169809341
epoch: 1 step: 26 loss: 0.08438318222761154
epoch: 1 step: 27 loss: 0.08949817717075348
epoch: 1 step: 28 loss: 0.08441370725631714
epoch: 1 step: 29 loss: 0.0715208500623703
epoch: 1 step: 30 loss: 0.08547709882259369
epoch: 1 step: 31 loss: 0.07643267512321472
epoch: 1 step: 32 loss: 0.07592073082923889
epoch: 1 step: 33 loss: 0.06881790608167648
epoch: 1 step: 34 loss: 0.062450114637613297
epoch: 1 step: 35 loss: 0.062182363122701645
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epoch: 1 step: 50 loss: 0.0526592917740345
epoch: 1 step: 51 loss: 0.05278330296278
epoch: 1 step: 52 loss: 0.05264641344547272
epoch: 1 step: 53 loss: 0.050422728061676025
epoch: 1 step: 54 loss: 0.049106113612651825
epoch: 1 step: 55 loss: 0.054241523146629333
epoch: 1 step: 56 loss: 0.05215660110116005

epoch: 1 step: 57 loss: 0.04997829347848892
epoch: 1 step: 58 loss: 0.04849347472190857
epoch: 1 step: 59 loss: 0.04923180863261223
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epoch: 1 step: 65 loss: 0.04760311543941498
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epoch: 1 step: 71 loss: 0.04856792837381363
epoch: 1 step: 72 loss: 0.04879268258810043
epoch: 1 step: 73 loss: 0.04980390891432762
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epoch: 1 step: 99 loss: 0.04849811643362045
epoch: 1 step: 100 loss: 0.04806233197450638
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epoch: 1 step: 2481 loss: 0.0037669034209102392
epoch: 1 step: 2482 loss: 0.003045632503926754
epoch: 1 step: 2483 loss: 0.002866320312023163
epoch: 1 step: 2484 loss: 0.0037900081370025873
epoch: 1 step: 2485 loss: 0.00343899754807353
epoch: 1 step: 2486 loss: 0.0030810730531811714
epoch: 1 step: 2487 loss: 0.003203991334885359
epoch: 1 step: 2488 loss: 0.0031308967154473066
epoch: 1 step: 2489 loss: 0.0027209664694964886
epoch: 1 step: 2490 loss: 0.004158376716077328
epoch: 1 step: 2491 loss: 0.004608082585036755
epoch: 1 step: 2492 loss: 0.002816480817273259
epoch: 1 step: 2493 loss: 0.003016311675310135
epoch: 1 step: 2494 loss: 0.0026756608858704567
epoch: 1 step: 2495 loss: 0.003271259367465973
epoch: 1 step: 2496 loss: 0.004935352131724358
epoch: 1 step: 2497 loss: 0.0037575310561805964
epoch: 1 step: 2498 loss: 0.004013530444353819
epoch: 1 step: 2499 loss: 0.0039054432418197393
epoch: 1 step: 2500 loss: 0.0026149749755859375

```

```

In [383... #Теперь прогоним на test датасете
cnt = 0
model.eval();
cnt, mean_acc, mean_CER = 0, 0, 0
for step, (img, label Oh, label) in enumerate(data_test_loader):
    img = Variable(img)
    pred = model(img)
    pred = torch.reshape(pred, (pred.shape[0], MAX_LEN, ALL_CHAR_SET_LEN))
    max_elems = torch.max(pred, 2)[1]
    pred_l = [''.join([ALL_CHAR_SET[i] for i in max_elems[j, :]]) for j in range(pred_l.shape[0])]
    metric = CharErrorRate()
    mean_acc += accuracy(pred_l, label)
    mean_CER += metric(pred_l, label)
#     print(f'CharErrorRate: {metric(pred_l, label)}, Accuracy: {accuracy(pred_l, label)}')
    cnt += 1
print(f'CharErrorRate: {mean_CER/cnt}, Accuracy: {mean_acc/cnt}')

CharErrorRate: 0.6857007741928101, Accuracy: 0.0

```

```
In [385... #сохраним веса модели
torch.save(model.state_dict(), '/Users/alenabuk/Tink_saved_model/tink_model.
```

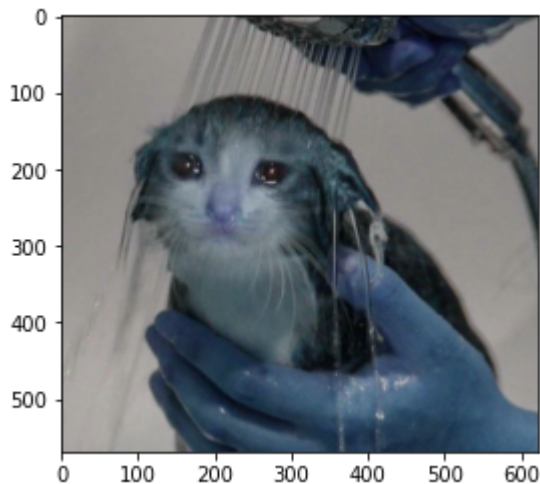
```
In [402... #Модель переобучилась
pred_l[0:10]
```

```
Out[402]: ['皖AK889F',
           '皖AK889F',
           '皖AK809F',
           '皖AK889F',
           '皖AK889F',
           '皖AK889F',
           '皖AK889F',
           '皖AK889F',
           '皖AK889F',
           '皖AK889F']
```

Так делать не стоило

```
In [405... img = cv2.imread('/Users/alenabuk/Downloads/funny-sad-cat-Favim.com-7790179.
plt.imshow(img)
```

```
Out[405]: <matplotlib.image.AxesImage at 0x7f9403e24250>
```



Но на models.resnet18 вообще неплохо выходило, где-то 0.9 ассурасу, ~0.14 CharErrorRate, просто тут реализация не такой хорошей получилась