

```
# ВНИМАНИЕ; версия Pillow установвлена по умолчанию - '7.0.0'  
# Эта версия ломает torchvision  
import PIL  
PIL.__version__  
  
    '7.1.2'
```

```
!pip uninstall -y Pillow  
!pip install -Iv Pillow==5.3.0
```



```

Found existing installation: Pillow 7.1.2
Uninstalling Pillow-7.1.2:
  Successfully uninstalled Pillow-7.1.2
Using pip 21.1.3 from /usr/local/lib/python3.7/dist-packages/pip (python 3.7)
Value for scheme.platlib does not match. Please report this to <https://github.com/pypa/pip/issues>
distutils: /usr/local/lib/python3.7/dist-packages
sysconfig: /usr/lib/python3.7/site-packages
Value for scheme.purelib does not match. Please report this to <https://github.com/pypa/pip/issues>
distutils: /usr/local/lib/python3.7/dist-packages
sysconfig: /usr/lib/python3.7/site-packages
Value for scheme.headers does not match. Please report this to <https://github.com/pypa/pip/issues>
distutils: /usr/local/include/python3.7/UNKNOWN
sysconfig: /usr/include/python3.7m/UNKNOWN
Value for scheme.scripts does not match. Please report this to <https://github.com/pypa/pip/issues>
distutils: /usr/local/bin
sysconfig: /usr/bin
Value for scheme.data does not match. Please report this to <https://github.com/pypa/pip/issues>
distutils: /usr/local
sysconfig: /usr
Additional context:
user = False
home = None
root = None
prefix = None
Non-user install because site-packages writable
Created temporary directory: /tmp/pip-ephem-wheel-cache-7wonmjoj
Created temporary directory: /tmp/pip-req-tracker-173oif3g
Initialized build tracking at /tmp/pip-req-tracker-173oif3g
Created build tracker: /tmp/pip-req-tracker-173oif3g
Entered build tracker: /tmp/pip-req-tracker-173oif3g
Created temporary directory: /tmp/pip-install-8xlnx0gd
1 location(s) to search for versions of pillow:
* https://pypi.org/simple/pillow/
Fetching project page and analyzing links: https://pypi.org/simple/pillow/
Getting page https://pypi.org/simple/pillow/
Found index url https://pypi.org/simple
Looking up "https://pypi.org/simple/pillow/" in the cache
Request header has "max_age" as 0, cache bypassed
Starting new HTTPS connection (1): pypi.org:443
https://pypi.org:443 "GET /simple/pillow/ HTTP/1.1" 200 203092
Updating cache with response from "https://pypi.org/simple/pillow/"
Caching due to etag
  Found link https://files.pythonhosted.org/packages/72/e6/692512c5d9dc97f83a91f
  Found link https://files.pythonhosted.org/packages/ea/dd/20ef35448408caa380cc4
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 Given no hashes to check 2 links for project 'pillow': discarding no candidates  
 Collecting Pillow==5.3.0

Created temporary directory: /tmp/pip-unpack-xhm3xw05

Looking up "<https://files.pythonhosted.org/packages/62/8c/230204b8e968f6db00c7>

No cache entry available

Starting new HTTPS connection (1): files.pythonhosted.org:443

```

Starting new HTTPS connection (1): files.pythonhosted.org:443
https://files.pythonhosted.org:443 "GET /packages/62/8c/230204b8e968f6db00c765
Downloading Pillow-5.3.0-cp37-cp37m-manylinux1_x86_64.whl (2.0 MB)
|████████████████████████████████████████| 2.0 MB 5.4 MB/s eta 0:00:01 Ignoring un
Updating cache with response from "https://files.pythonhosted.org/packages/62/
Caching due to etag
|████████████████████████████████████████| 2.0 MB 5.4 MB/s
Added Pillow==5.3.0 from https://files.pythonhosted.org/packages/62/8c/230204b
Removed Pillow==5.3.0 from https://files.pythonhosted.org/packages/62/8c/23020
Created temporary directory: /tmp/pip-unpack-5y_k2ge5
Installing collected packages: Pillow
Value for scheme.platlib does not match. Please report this to <https://github
distutils: /usr/local/lib/python3.7/dist-packages
sysconfig: /usr/lib/python3.7/site-packages
Value for scheme.purelib does not match. Please report this to <https://github
distutils: /usr/local/lib/python3.7/dist-packages
sysconfig: /usr/lib/python3.7/site-packages
Value for scheme.headers does not match. Please report this to <https://github
distutils: /usr/local/include/python3.7/Pillow
sysconfig: /usr/include/python3.7m/Pillow

```

**ВНИМАНИЕ:** На этом этапе обязательно перезагрузить рантайм (Runtime -> Restart Runtime). Иначе версия 5.3.0 не будет загружена в рантайм.

После перезапуска рантайма следует продолжить исполнять ячейки далее.

```
user = False
```

## Физтех-Школа Прикладной математики и информатики (ФПМИ) МФТИ

```
distutils: /usr/local/lib/python3.7/dist-packages
```

### ▼ Путешествие по Спрингфилду.

Сегодня вам предстоит помочь телекомпании FOX в обработке их контента. Как вы знаете сериал Симсоны идет на телеэкранах более 25 лет и за это время скопилось очень много видео материала. Персонажи менялись вместе с изменяющимися графическими технологиями и Гомер 2018 не очень похож на Гомера 1989. Нашей задачей будет научиться классифицировать персонажей проживающих в Спрингфилде. Думаю, что нет смысла представлять каждого из них в отдельности.





## ▼ Установка зависимостей

```
!pip install -U torch torchvision
```

```
Requirement already satisfied: torch in /usr/local/lib/python3.7/dist-packages (
Requirement already satisfied: torchvision in /usr/local/lib/python3.7/dist-pack
Requirement already satisfied: typing-extensions in /usr/local/lib/python3.7/dis
Requirement already satisfied: numpy in /usr/local/lib/python3.7/dist-packages (
Requirement already satisfied: pillow!=8.3.0,>=5.3.0 in /usr/local/lib/python3.7
```

```
# ИСПРАВЛЕНИЕ: к сожалению этот код не работает у меня на коллабе
# плюс что-то намудрено с именами в репозитории pytorch
```

```
# установка подходящей версии torch
```

```
#from os.path import exists
#from wheel.pep425tags import get_abbr_impl, get_impl_ver, get_abi_tag
#platform = '{}{}-{}'.format(get_abbr_impl(), get_impl_ver(), get_abi_tag())
#cuda_output = !ldconfig -p|grep cudart.so|sed -e 's/.*\.[0-9]*\.[0-9]*$/cu\1
#accelerator = cuda_output[0] if exists('/dev/nvidia0') else 'cpu'
```

```
#!pip install -q http://download.pytorch.org/whl/{accelerator}/torch-1.5.0%2B{platfor
#import torch
```

```
# ИСПРАВЛЕНИЕ:
# Вручную ищем и устанавливаем подходящую версию
```

```
# https://download.pytorch.org/whl/torch_stable.html
!pip install -q 'https://download.pytorch.org/whl/cu101/torch-1.5.0%2Bcu101-cp36-cp36
import torch
```

**ERROR: torch-1.5.0+cu101-cp36-cp36m-linux\_x86\_64.whl is not a supported wheel on**

```
# we will verify that GPU is enabled for this notebook
# following should print: CUDA is available! Training on GPU ...
#
# if it prints otherwise, then you need to enable GPU:
# from Menu > Runtime > Change Runtime Type > Hardware Accelerator > GPU
```

```
import torch
import numpy as np
```

```
train_on_gpu = torch.cuda.is_available()
```

```
if not train_on_gpu:
    print('CUDA is not available. Training on CPU ...')
else:
    print('CUDA is available! Training on GPU ...')
```

CUDA is available! Training on GPU ...

```
# ВНИМАНИЕ: мы это уже сделали вначале ноутбука
```

```
# нам необходима версия pillow 5.3.0
# удалим старую версию и установим новую
#!pip uninstall -y Pillow
#!pip install Pillow==5.3.0
#import PIL
#print(PIL.PILLOW_VERSION)
# здесь должна быть версия 5.3.0. если это не так перехгрузите данный ноутбук:
# Menu > Runtime > Restart Runtime
```

Чтобы изменить содержимое ячейки, дважды нажмите на нее (или выберите "Ввод")

```
from google.colab import drive
drive.mount('/content/gdrive/')
```

Mounted at /content/gdrive/

---

**ВНИМАНИЕ: скачайте датасет с каггла и положите его в корень своего гугл диска!**

---

```
# ИСПРАВЛЕНИЕ
```

```

#!unzip -q /content/gdrive/My\ Drive/simpsons/data/dataset.zip -d train
#!unzip -q /content/gdrive/My\ Drive/simpsons/data/testset.zip -d test

!unzip -q /content/gdrive/My\ Drive/journey-springfield.zip

!ls train

simpsons_dataset

```

```

!nvidia-smi
import torch
torch.cuda.is_available()

```

Mon Nov 29 16:08:23 2021

+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+											
NVIDIA-SMI 495.44				Driver Version: 460.32.03				CUDA Version: 11.2		+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+	
				+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+							
GPU	Name		Persistence-M	Bus-Id	Disp.A	Volatile	Uncorr. ECC				
Fan	Temp	Perf	Pwr:Usage/Cap		Memory-Usage	GPU-Util	Compute M.				
							MIG M.				
=====+=====+=====+=====+=====+=====+=====+=====+=====+=====											
0	Tesla K80		Off	00000000:00:04.0	Off		0				
N/A	36C	P8	27W / 149W		3MiB / 11441MiB	0%	Default				
							N/A				
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+											

Processes:									
GPU	GI	CI	PID	Type	Process name	GPU Memory Usage			
	ID	ID							
No running processes found									

True

В нашем тесте будет 990 карточек, для которых вам будет необходимо предсказать класс.

```

import pickle
import numpy as np
from skimage import io

from tqdm import tqdm, tqdm_notebook
from PIL import Image
from pathlib import Path

from torchvision import transforms
from multiprocessing.pool import ThreadPool
from sklearn.preprocessing import LabelEncoder

```



```
from torch.utils.data import Dataset, DataLoader
import torch.nn as nn
```

```
from matplotlib import colors, pyplot as plt
%matplotlib inline
```

```
# в sklearn не все гладко, чтобы в colab удобно выводить картинки
# мы будем игнорировать warnings
import warnings
warnings.filterwarnings(action='ignore', category=DeprecationWarning)
```

```
/usr/local/lib/python3.7/dist-packages/skimage/io/manage_plugins.py:23: UserWarn
from .collection import imread_collection_wrapper
```

```
# разные режимы датасета
DATA_MODES = ['train', 'val', 'test']
# все изображения будут масштабированы к размеру 224x224 px
RESIZE_SIZE = 224
# работаем на видеокарте
DEVICE = torch.device("cuda")
```

[https://jhui.github.io/2018/02/09/PyTorch-Data-loading-preprocess\\_torchvision/](https://jhui.github.io/2018/02/09/PyTorch-Data-loading-preprocess_torchvision/)

Ниже мы используем wrapper над датасетом для удобной работы. Вам стоит понимать, что происходит с LabelEncoder и с torch.Transformation.

ToTensor конвертирует PIL Image с параметрами в диапазоне [0, 255] (как все пиксели) в FloatTensor размера (C x H x W) [0,1], затем производится масштабирование:  $\frac{\text{input} - \mu}{\text{standard deviation}}$ , константы - средние и дисперсии по каналам на основе ImageNet

Стоит также отметить, что мы переопределяем метод **getitem** для удобства работы с данной структурой данных. Также используется LabelEncoder для преобразования строковых меток классов в id и обратно. В описании датасета указано, что картинки разного размера, так как брались напрямую с видео, поэтому следуем привести их к одному размеру (это делает метод `_prepare_sample`)

```
class SimpsonsDataset(Dataset):
    """
    Датасет с картинками, который паралельно подгружает их из папок
    производит скалирование и превращение в торчевые тензоры
    """
    def __init__(self, files, mode):
        super().__init__()
```

```
# список файлов для загрузки
self.files = sorted(files)
# режим работы
self.mode = mode

if self.mode not in DATA_MODES:
    print(f"{self.mode} is not correct; correct modes: {DATA_MODES}")
    raise NameError

self.len_ = len(self.files)

self.label_encoder = LabelEncoder()

if self.mode != 'test':
    self.labels = [path.parent.name for path in self.files]
    self.label_encoder.fit(self.labels)

    with open('label_encoder.pkl', 'wb') as le_dump_file:
        pickle.dump(self.label_encoder, le_dump_file)

def __len__(self):
    return self.len_

def load_sample(self, file):
    image = Image.open(file)
    image.load()
    return image

def __getitem__(self, index):
    # для преобразования изображений в тензоры PyTorch и нормализации входа
    transform = transforms.Compose([
        transforms.ToTensor(),
        transforms.Normalize([0.485, 0.456, 0.406], [0.229, 0.224, 0.225])
    ])
    x = self.load_sample(self.files[index])
    x = self._prepare_sample(x)
    x = np.array(x / 255, dtype='float32')
    x = transform(x)
    if self.mode == 'test':
        return x
    else:
        label = self.labels[index]
        label_id = self.label_encoder.transform([label])
        y = label_id.item()
        return x, y

def _prepare_sample(self, image):
    image = image.resize((RESCALE_SIZE, RESCALE_SIZE))
    return np.array(image)
```

```
def imshow(inp, title=None, plt_ax=plt, default=False):
    """Imshow для тензоров"""
    inp = inp.numpy().transpose((1, 2, 0))
    mean = np.array([0.485, 0.456, 0.406])
    std = np.array([0.229, 0.224, 0.225])
    inp = std * inp + mean
    inp = np.clip(inp, 0, 1)
    plt_ax.imshow(inp)
    if title is not None:
        plt_ax.set_title(title)
    plt_ax.grid(False)
```

```
TRAIN_DIR = Path('train/simpsons_dataset')
TEST_DIR = Path('testset/testset')
```

```
train_val_files = sorted(list(TRAIN_DIR.rglob('*.jpg')))
test_files = sorted(list(TEST_DIR.rglob('*.jpg')))
```

```
from sklearn.model_selection import train_test_split
```

```
train_val_labels = [path.parent.name for path in train_val_files]
train_files, val_files = train_test_split(train_val_files, test_size=0.25, \
                                          stratify=train_val_labels)
```

```
val_dataset = SimpsonsDataset(val_files, mode='val')
```

```
# uncomment if you have problem with pillow
# def register_extension(id, extension): Image.EXTENSION[extension.lower()] = id.uppe
# Image.register_extension = register_extension
# def register_extensions(id, extensions):
#     for extension in extensions: register_extension(id, extension)
# Image.register_extensions = register_extensions
```

Давайте посмотрим на наших героев внутри датасета.

```
fig, ax = plt.subplots(nrows=3, ncols=3, figsize=(8, 8), \
                       sharey=True, sharex=True)
for fig_x in ax.flatten():
    random_characters = int(np.random.uniform(0,1000))
    im_val, label = val_dataset[random_characters]
    img_label = " ".join(map(lambda x: x.capitalize(), \
                             val_dataset.label_encoder.inverse_transform([label])[0].split('_')))
    imshow(im_val.data.cpu(), \
           title=img_label, plt_ax=fig_x)
```





Можете добавить ваши любимые сцены и классифицировать их. (веселые результаты можно кидать в чат)

## ▼ Построение нейросети

Запустить данную сеть будет вашим мини-заданием на первую неделю, чтобы было проще участвовать в соревновании.

Данная архитектура будет очень простой и нужна для того, чтобы установить базовое понимание и получить простенький сабмит на Kaggle

Описание слоев:

1. размерность входа: 3x224x224
2. размерности после слоя: 8x111x111
3. 16x54x54
4. 32x26x26
5. 64x12x12
6. выход: 96x5x5

```
# Очень простая сеть
class SimpleCnn(nn.Module):
```

```
def __init__(self, n_classes):
    super().__init__()
    self.conv1 = nn.Sequential(
        nn.Conv2d(in_channels=3, out_channels=8, kernel_size=3),
        nn.ReLU(),
        nn.MaxPool2d(kernel_size=2)
    )
    self.conv2 = nn.Sequential(
        nn.Conv2d(in_channels=8, out_channels=16, kernel_size=3),
        nn.ReLU(),
        nn.MaxPool2d(kernel_size=2)
    )
    self.conv3 = nn.Sequential(
        nn.Conv2d(in_channels=16, out_channels=32, kernel_size=3),
        nn.ReLU(),
        nn.MaxPool2d(kernel_size=2)
    )
    self.conv4 = nn.Sequential(
        nn.Conv2d(in_channels=32, out_channels=64, kernel_size=3),
        nn.ReLU(),
        nn.MaxPool2d(kernel_size=2)
    )
    self.conv5 = nn.Sequential(
        nn.Conv2d(in_channels=64, out_channels=96, kernel_size=3),
        nn.ReLU(),
        nn.MaxPool2d(kernel_size=2)
    )

    self.out = nn.Linear(96 * 5 * 5, n_classes)
```

```
def forward(self, x):
    x = self.conv1(x)
    x = self.conv2(x)
    x = self.conv3(x)
    x = self.conv4(x)
    x = self.conv5(x)

    x = x.view(x.size(0), -1)
    logits = self.out(x)
    return logits
```

```
def fit_epoch(model, train_loader, criterion, optimizer):
    running_loss = 0.0
    running_corrects = 0
    processed_data = 0

    for inputs, labels in train_loader:
        inputs = inputs.to(DEVICE)
```

```
labels = labels.to(DEVICE)
optimizer.zero_grad()

outputs = model(inputs)
loss = criterion(outputs, labels)
loss.backward()
optimizer.step()
preds = torch.argmax(outputs, 1)
running_loss += loss.item() * inputs.size(0)
running_corrects += torch.sum(preds == labels.data)
processed_data += inputs.size(0)

train_loss = running_loss / processed_data
train_acc = running_corrects.cpu().numpy() / processed_data
return train_loss, train_acc

def eval_epoch(model, val_loader, criterion):
    model.eval()
    running_loss = 0.0
    running_corrects = 0
    processed_size = 0

    for inputs, labels in val_loader:
        inputs = inputs.to(DEVICE)
        labels = labels.to(DEVICE)

        with torch.set_grad_enabled(False):
            outputs = model(inputs)
            loss = criterion(outputs, labels)
            preds = torch.argmax(outputs, 1)

            running_loss += loss.item() * inputs.size(0)
            running_corrects += torch.sum(preds == labels.data)
            processed_size += inputs.size(0)
    val_loss = running_loss / processed_size
    val_acc = running_corrects.double() / processed_size
    return val_loss, val_acc

def train(train_files, val_files, model, epochs, batch_size):
    train_loader = DataLoader(train_dataset, batch_size=batch_size, shuffle=True)
    val_loader = DataLoader(val_dataset, batch_size=batch_size, shuffle=False)

    history = []
    log_template = "\nEpoch {ep:03d} train_loss: {t_loss:0.4f} \
val_loss {v_loss:0.4f} train_acc {t_acc:0.4f} val_acc {v_acc:0.4f}"

    with tqdm(desc="epoch", total=epochs) as pbar_outer:
        opt = torch.optim.Adam(model.parameters())
        criterion = nn.CrossEntropyLoss()
```

```

for epoch in range(epochs):
    train_loss, train_acc = fit_epoch(model, train_loader, criterion, opt)
    print("loss", train_loss)

    val_loss, val_acc = eval_epoch(model, val_loader, criterion)
    history.append((train_loss, train_acc, val_loss, val_acc))

    pbar_outer.update(1)
    tqdm.write(log_template.format(ep=epoch+1, t_loss=train_loss,\
                                   v_loss=val_loss, t_acc=train_acc, v_acc=va

return history

def predict(model, test_loader):
    with torch.no_grad():
        logits = []

    for inputs in test_loader:
        inputs = inputs.to(DEVICE)
        model.eval()
        outputs = model(inputs).cpu()
        logits.append(outputs)

    probs = nn.functional.softmax(torch.cat(logits), dim=-1).numpy()
    return probs

n_classes = len(np.unique(train_val_labels))
simple_cnn = SimpleCnn(n_classes).to(DEVICE)
print("we will classify :{}".format(n_classes))
print(simple_cnn)

we will classify :42
SimpleCnn(
  (conv1): Sequential(
    (0): Conv2d(3, 8, kernel_size=(3, 3), stride=(1, 1))
    (1): ReLU()
    (2): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=Fa
  )
  (conv2): Sequential(
    (0): Conv2d(8, 16, kernel_size=(3, 3), stride=(1, 1))
    (1): ReLU()
    (2): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=Fa
  )
  (conv3): Sequential(
    (0): Conv2d(16, 32, kernel_size=(3, 3), stride=(1, 1))
    (1): ReLU()
    (2): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=Fa
  )
  (conv4): Sequential(
    (0): Conv2d(32, 64, kernel_size=(3, 3), stride=(1, 1))
    (1): ReLU()
    (2): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=Fa

```



```

    )
    (conv5): Sequential(
      (0): Conv2d(64, 96, kernel_size=(3, 3), stride=(1, 1))
      (1): ReLU()
      (2): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=False)
    )
    (out): Linear(in_features=2400, out_features=42, bias=True)
  )

```

Запустим обучение сети.

```

if val_dataset is None:
    val_dataset = SimpsonsDataset(val_files, mode='val')

train_dataset = SimpsonsDataset(train_files, mode='train')

history = train(train_dataset, val_dataset, model=simple_cnn, epochs=20, batch_size=4)

```

```

Epoch 001 train_loss: 0.4100      val_loss 0.9810 train_acc 0.8778 val_acc 0.78
loss 0.31203843790764474
epoch: 10%|███████| 2/20 [07:00<1:03:09, 210.53s/it]
Epoch 002 train_loss: 0.3120      val_loss 0.9580 train_acc 0.9087 val_acc 0.79
loss 0.25523892327945585
epoch: 15%|███████| 3/20 [10:32<59:48, 211.07s/it]
Epoch 003 train_loss: 0.2552      val_loss 1.4474 train_acc 0.9231 val_acc 0.75
loss 0.2255947984003141
epoch: 20%|███████| 4/20 [14:03<56:16, 211.03s/it]
Epoch 004 train_loss: 0.2256      val_loss 1.2638 train_acc 0.9329 val_acc 0.79
loss 0.21121878178637152
epoch: 25%|███████| 5/20 [17:29<52:15, 209.03s/it]
Epoch 005 train_loss: 0.2112      val_loss 1.4965 train_acc 0.9402 val_acc 0.75
loss 0.19090224160045172
epoch: 30%|███████| 6/20 [21:02<49:04, 210.35s/it]
Epoch 006 train_loss: 0.1909      val_loss 1.3831 train_acc 0.9432 val_acc 0.78
loss 0.19499205385086985
epoch: 35%|███████| 7/20 [24:34<45:43, 211.04s/it]
Epoch 007 train_loss: 0.1950      val_loss 1.3612 train_acc 0.9452 val_acc 0.80
loss 0.18293535023803104
epoch: 40%|███████| 8/20 [28:06<42:17, 211.48s/it]
Epoch 008 train_loss: 0.1829      val_loss 1.4848 train_acc 0.9484 val_acc 0.79
loss 0.16290664706896835
epoch: 45%|███████| 9/20 [31:38<38:48, 211.65s/it]
Epoch 009 train_loss: 0.1629      val_loss 1.7513 train_acc 0.9524 val_acc 0.79
loss 0.17607613755810095
epoch: 50%|███████| 10/20 [35:11<35:18, 211.89s/it]
Epoch 010 train_loss: 0.1761      val_loss 1.5727 train_acc 0.9499 val_acc 0.79
loss 0.16120736911657324
epoch: 55%|███████| 11/20 [38:43<31:46, 211.87s/it]
Epoch 011 train_loss: 0.1612      val_loss 1.7504 train_acc 0.9559 val_acc 0.79
loss 0.14267688926744293
epoch: 60%|███████| 12/20 [42:16<28:17, 212.21s/it]
Epoch 012 train_loss: 0.1427      val_loss 1.7298 train_acc 0.9599 val_acc 0.79
loss 0.1759391232708972

```

```

epoch: 65%|██████████ | 13/20 [45:47<24:44, 212.06s/it]
Epoch 013 train_loss: 0.1759      val_loss 2.0087 train_acc 0.9554 val_acc 0.78
loss 0.15421034199017386
epoch: 70%|██████████ | 14/20 [49:19<21:10, 211.80s/it]
Epoch 014 train_loss: 0.1542      val_loss 1.8856 train_acc 0.9596 val_acc 0.80
loss 0.1558329845728597
epoch: 75%|██████████ | 15/20 [52:50<17:38, 211.75s/it]
Epoch 015 train_loss: 0.1558      val_loss 1.9917 train_acc 0.9604 val_acc 0.79
loss 0.14853542523689953
epoch: 80%|██████████ | 16/20 [56:23<14:07, 212.00s/it]
Epoch 016 train_loss: 0.1485      val_loss 1.9018 train_acc 0.9620 val_acc 0.78
loss 0.15095704534470883
epoch: 85%|██████████ | 17/20 [59:54<10:35, 211.69s/it]
Epoch 017 train_loss: 0.1510      val_loss 2.0294 train_acc 0.9607 val_acc 0.80
loss 0.15715820281295478
epoch: 90%|██████████ | 18/20 [1:03:10<06:54, 207.18s/it]
Epoch 018 train_loss: 0.1572      val_loss 2.3050 train_acc 0.9618 val_acc 0.79
loss 0.1583003557895689
epoch: 95%|██████████ | 19/20 [1:06:29<03:24, 204.59s/it]
Epoch 019 train_loss: 0.1583      val_loss 2.5877 train_acc 0.9633 val_acc 0.79
loss 0.13913216482291704
epoch: 100%|██████████ | 20/20 [1:09:46<00:00, 209.31s/it]
Epoch 020 train_loss: 0.1391      val_loss 2.1661 train_acc 0.9666 val_acc 0.80

```

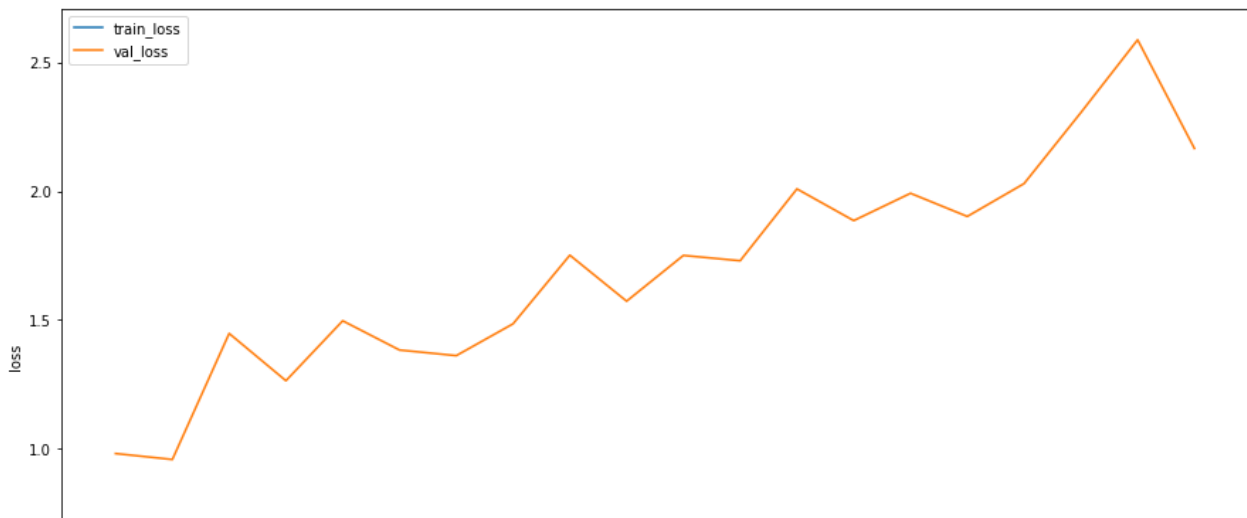
Построим кривые обучения

```
loss, acc, val_loss, val_acc = zip(*history)
```

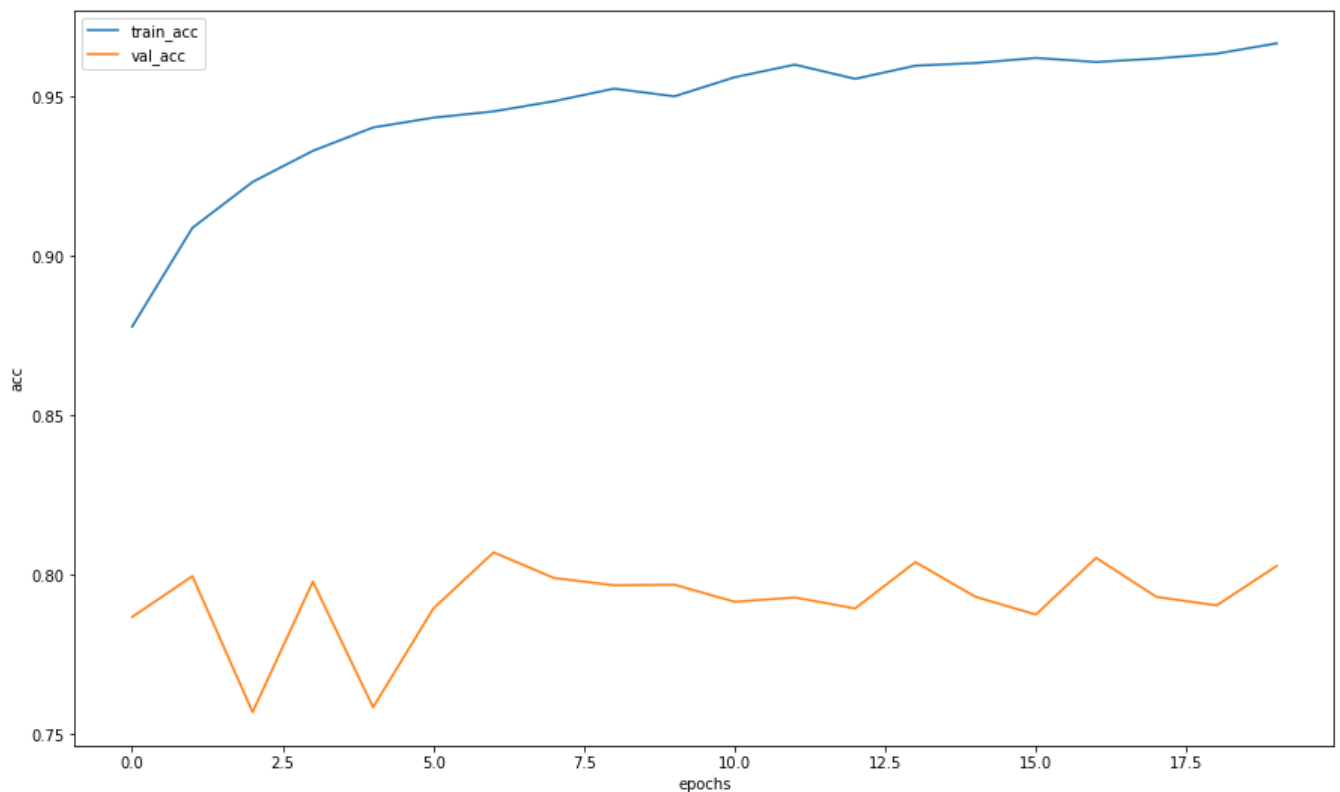
```

plt.figure(figsize=(15, 9))
plt.plot(loss, label="train_loss")
plt.plot(val_loss, label="val_loss")
plt.legend(loc='best')
plt.xlabel("epochs")
plt.ylabel("loss")
plt.show()

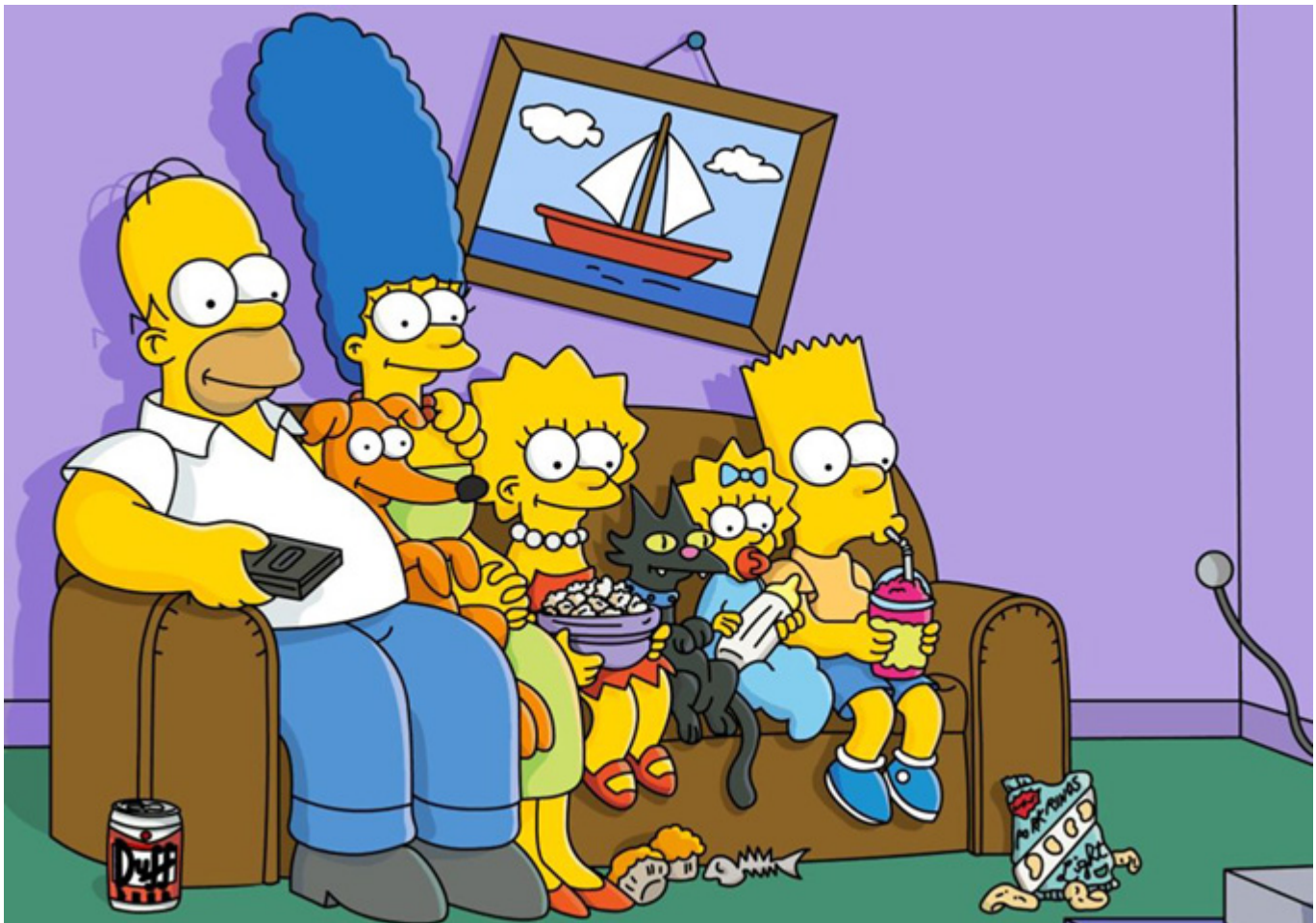
```



```
plt.figure(figsize=(15, 9))
plt.plot(acc, label="train_acc")
plt.plot(val_acc, label="val_acc")
plt.legend(loc='best')
plt.xlabel("epochs")
plt.ylabel("acc")
plt.show()
```



▼ Ну и что теперь со всем этим делать?



Хорошо бы понять, как сделать сабмит. У нас есть сеть и методы `eval` у нее, которые позволяют перевести сеть в режим предсказания. Стоит понимать, что у нашей модели на последнем слое стоит `softmax`, которые позволяет получить вектор вероятностей того, что объект относится к тому или иному классу. Давайте воспользуемся этим.

```
def predict_one_sample(model, inputs, device=DEVICE):  
    """Предсказание, для одной картинки"""  
    with torch.no_grad():  
        inputs = inputs.to(device)  
        model.eval()  
        logit = model(inputs).cpu()  
        probs = torch.nn.functional.softmax(logit, dim=-1).numpy()  
    return probs
```

```
random_characters = int(np.random.uniform(0,1000))  
ex_img, true_label = val_dataset[random_characters]  
probs_im = predict_one_sample(simple_cnn, ex_img.unsqueeze(0))
```



```
idxs = list(map(int, np.random.uniform(0,1000, 20)))
imgs = [val_dataset[id][0].unsqueeze(0) for id in idxs]

probs_ims = predict(simple_cnn, imgs)
```

```
label_encoder = pickle.load(open("label_encoder.pkl", 'rb'))
```

```
y_pred = np.argmax(probs_ims, -1)
```

```
actual_labels = [val_dataset[id][1] for id in idxs]
```

```
preds_class = [label_encoder.classes_[i] for i in y_pred]
```

Обратите внимание, что метрика, которую необходимо оптимизировать в конкурсе — f1-score. Вычислим целевую метрику на валидационной выборке.

```
from sklearn.metrics import f1_score
```

```
f1_score(actual_labels, y_pred, average='micro')
```

```
0.85
```

Сделаем классную визуализацию, чтобы посмотреть насколько сеть уверена в своих ответах. Можете использовать это, чтобы отлаживать правильность вывода.

```
import matplotlib.patches as patches
from matplotlib.font_manager import FontProperties

fig, ax = plt.subplots(nrows=3, ncols=3, figsize=(12, 12), \
                        sharey=True, sharex=True)
for fig_x in ax.flatten():
    random_characters = int(np.random.uniform(0,1000))
    im_val, label = val_dataset[random_characters]
    img_label = " ".join(map(lambda x: x.capitalize(), \
                             val_dataset.label_encoder.inverse_transform([label])[0].split('_')))

    imshow(im_val.data.cpu(), \
           title=img_label, plt_ax=fig_x)

    actual_text = "Actual : {}".format(img_label)

    fig_x.add_patch(patches.Rectangle((0, 53), 86, 35, color='white'))
```

```

font0 = FontProperties()
font = font0.copy()
font.set_family("fantasy")
prob_pred = predict_one_sample(simple_cnn, im_val.unsqueeze(0))
predicted_proba = np.max(prob_pred)*100
y_pred = np.argmax(prob_pred)

predicted_label = label_encoder.classes_[y_pred]
predicted_label = predicted_label[:len(predicted_label)//2] + '\n' + predicted_label[len(predicted_label)//2:]
predicted_text = "{} : {:.0f}%".format(predicted_label,predicted_proba)

fig_x.text(1, 59, predicted_text , horizontalalignment='left', fontproperties=font,
          verticalalignment='top',fontsize=8, color='black',fontweight='bold')

```



Попробуйте найти те классы, которые сеть не смогла распознать. Изучите данную проблему, это понадобится в дальнейшем.

▼ Submit на Kaggle



```
test_dataset = SimpsonsDataset(test_files, mode="test")
test_loader = DataLoader(test_dataset, shuffle=False, batch_size=4)
probs = predict(simple_cnn, test_loader)
```

```
preds = label_encoder.inverse_transform(np.argmax(probs, axis=1))
test_filenames = [path.name for path in test_dataset.files]
```

```
# ДОБАВЛЕНО: создание сабмита
import pandas as pd
df = pd.DataFrame()
df['Id'] = test_filenames
```

```
df['Expected'] = preds
df.to_csv('gdrive/My Drive/simpsons_simple_cnn_baseline_final.csv', index=False)
# файл появится у вас на гугл диске

! ls

characters_illustration.png  label_encoder.pkl  sample_submission.csv  train
gdrive                      sample_data        testset

# ЗДЕСЬ что-то не работает. Не понятно зачем читают лейблы
#import pandas as pd
#my_submit = pd.read_csv("gdrive/My Drive/simpsons/data/labels.csv")
#my_submit = pd.DataFrame({'Image_id': test_filenames, 'Expected': preds})
#my_submit.head()

# TODO : сделайте сабмит (это важно, если Вы не справляетесь, но дошли до этой ячейки
```

## ▼ Приключение?

А теперь самое интересное, мы сделали простенькую сверточную сеть и смогли отправить сабмит, но получившийся скор нас явно не устраивает. Надо с этим что-то сделать.

Несколько срочных улучшений для нашей сети, которые наверняка пришли Вам в голову:

- Учим дольше и изменяем гиперпараметры сети
- learning rate, batch size, нормализация картинки и вот это всё
- Кто же так строит нейронные сети? А где пулинги и батч нормы? Надо добавлять
- Ну разве Адам наше все? [adamW](#) для практика, [статья для любителей](#) (очень хороший анализ), [наши](#) эксперименты для заинтересованных.
- Ну разве это deep learning? Вот ResNet и Inception, которые можно зафайнтюнить под наши данные, вот это я понимаю (можно и обучить в колабе, а можно и [готовые](#) скачать).
- Данных не очень много, можно их аугментировать и доучиться на новом датасете (который уже будет состоять из, как пример аугментации, перевернутых изображений)
- Стоит подумать об ансамблях

Надеюсь, что у Вас получится!





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✓ 0 сек. выполнено в 21:06

