```
#import os
#import zipfile
#if not os.path.exists('./apple2orange'):
#    if os.path.exists('../input/apple2orange.zip'):
#        with zipfile.ZipFile('/content/apple2orange.zip', 'r') as zip_obj:
#            zip_obj.extractall('./')
#    else:
#        !wget https://people.eecs.berkeley.edu/~taesung_park/CycleGAN/datasets/apple2orange.zip
#        with zipfile.ZipFile('/content/apple2orange.zip', 'r') as zip_obj:
#            zip_obj.extractall('./')
```

Реализация CycleGAN

Цель обучения - превратить портреты лягушек в портреты людей. За датасет лягушек спасибо Ольги Вишневской и паблику в вк Пепеланджело

```
import os
import zipfile
with zipfile.ZipFile('/content/face2peepo.zip', 'r') as zip_obj:
  zip_obj.extractall('./')
```

```
import torch
import os
import torch.nn.functional as F
import numpy as np
from torch import nn
import itertools
from tqdm.notebook import tqdm
from torch.utils.data import DataLoader, Dataset
from torchvision.transforms import transforms
from PIL import Image
import matplotlib.pyplot as plt
from IPython.display import clear_output
from IPython.display import clear_output
plt.figure(figsize=(18, 6))
```

```
<Figure size 1296x432 with 0 Axes>
<Figure size 1296x432 with 0 Axes>
```

```
class ResidualBlock(nn.Module):
    def __init__(self, in_features):
        super(ResidualBlock, self).__init__()

        conv_block = [  nn.ReflectionPad2d(1),
                        nn.Conv2d(in_features, in_features, 3),
                        nn.InstanceNorm2d(in_features),
                        nn.ReLU(inplace=True),
                        nn.ReflectionPad2d(1),
                        nn.Conv2d(in_features, in_features, 3),
                        nn.InstanceNorm2d(in_features)  ]

        self.conv_block = nn.Sequential(*conv_block)

    def forward(self, x):
        return x + self.conv_block(x)
```

```
class Generator(nn.Module):
    def __init__(self, input_nc, output_nc, n_residual_blocks=9):
        super(Generator, self).__init__()

        # Initial convolution block
        model = [   nn.ReflectionPad2d(3),
                    nn.Conv2d(input_nc, 64, 7),
                    nn.InstanceNorm2d(64),
                    nn.ReLU(inplace=True) ]

        # Downsampling
        in_features = 64
        out_features = in_features*2
        for _ in range(2):
            model += [  nn.Conv2d(in_features, out_features, 3, stride=2, padding=1),
                        nn.InstanceNorm2d(out_features),
                        nn.ReLU(inplace=True) ]
            in_features = out_features
            out_features = in_features*2

        # Residual blocks
        for _ in range(n_residual_blocks):
            model += [ResidualBlock(in_features)]

        # Upsampling
        out_features = in_features//2
        for _ in range(2):
            model += [  nn.ConvTranspose2d(in_features, out_features, 3, stride=2, padding=1, output_paddin
                        nn.InstanceNorm2d(out_features),
                        nn.ReLU(inplace=True) ]
            in_features = out_features
            out_features = in_features//2

        # Output layer
        model += [  nn.ReflectionPad2d(3),
                    nn.Conv2d(64, output_nc, 7),
                    nn.Tanh() ]

        self.model = nn.Sequential(*model)

    def forward(self, x):
        return self.model(x)

```

```
class Discriminator(nn.Module):
    def __init__(self, input_nc):
        super(Discriminator, self).__init__()

        # A bunch of convolutions one after another
        model = [   nn.Conv2d(input_nc, 64, 4, stride=2, padding=1),
                    nn.LeakyReLU(0.2, inplace=True) ]

        model += [  nn.Conv2d(64, 128, 4, stride=2, padding=1),
                    nn.InstanceNorm2d(128),
                    nn.LeakyReLU(0.2, inplace=True) ]

        model += [  nn.Conv2d(128, 256, 4, stride=2, padding=1),
                    nn.InstanceNorm2d(256),
                    nn.LeakyReLU(0.2, inplace=True) ]

        model += [  nn.Conv2d(256, 512, 4, padding=1),
                    nn.InstanceNorm2d(512),
                    nn.LeakyReLU(0.2, inplace=True) ]

        # FCN classification layer
        model += [nn.Conv2d(512, 1, 4, padding=1)]

        self.model = nn.Sequential(*model)

    def forward(self, x):
        x =  self.model(x)
        # Average pooling and flatten
        return F.avg_pool2d(x, x.size()[2:]).view(x.size()[0], -1)
```

```
class Dataset(torch.utils.data.Dataset):
  def __init__(self):
    super().__init__()
    self.transforms  = transforms.Compose([
                transforms.Resize(int(256*1.12)),
                transforms.RandomCrop(256),
                transforms.RandomRotation(20),
                transforms.ToTensor(),
                transforms.Normalize((0.5,0.5,0.5), (0.5,0.5,0.5)),
    ]
    )
    self.files_A = sorted(os.path.join('/content/face2peepo/TrainA', i) for i in os.listdir('/content/face2
    self.files_B = sorted(os.path.join('/content/face2peepo/TrainB', i) for i in os.listdir('/content/face2
    self.files_A = list(filter(lambda x: Image.open(x).layers==3, self.files_A))
    self.files_B = list(filter(lambda x: Image.open(x).layers==3, self.files_B))

  def __getitem__(self,index):
    item_A = self.transforms(Image.open(self.files_A[index % len(self.files_A)]))
    item_B = self.transforms(Image.open(self.files_B[index % len(self.files_B)]))
    return item_A, item_B

  def __len__(self):
    return max(len(self.files_A), len(self.files_B))
```

```
def train():
  true_ = torch.Tensor([[1]]).cuda()
  false_ = torch.Tensor([[0]]).cuda()
  for epoch in range(num_epoch):
    pbar = tqdm(total=len(data_loader))
    for A,B in data_loader:
      if A.shape[1]==1 or B.shape[1]==1:
        continue
      losses_G_B2A_batch = []
      losses_G_A2B_batch = []
      losses_cycle_A_batch = []
      losses_cycle_B_batch = []
      losses_D_A_batch = []
      losses_D_B_batch = []

      A = A.to(DEVICE)
      B = B.to(DEVICE)
      optimizer_G.zero_grad()

      #true_ = torch.Tensor([[1]]).cuda()
      #false_ = torch.Tensor([[0]]).cuda()

      same_A = netG_B2A(A)
      same_B = netG_A2B(B)
      loss_identity_B = loss_identity(same_B, B)*5.0
      loss_identity_A = loss_identity(same_A, A)*5.0
      fake_A = netG_B2A(B)
```

```
        fake_B = netG_A2B(A)
        pred_fake_A = netD_A(fake_A)
        pred_fake_B = netD_B(fake_B)

        Loss_GAN_B2A = loss_GAN(pred_fake_A, false_)
        Loss_GAN_A2B = loss_GAN(pred_fake_B, false_)
        losses_G_A2B_batch.append(Loss_GAN_A2B.item())
        losses_G_B2A_batch.append(Loss_GAN_B2A.item())

        recovered_A = netG_B2A(fake_B)
        recovered_B = netG_A2B(fake_A)

        Loss_cycle_A = loss_cycle(recovered_A,A)*10.0
        Loss_cycle_B = loss_cycle(recovered_B,B)*10.0

        losses_cycle_A_batch.append(Loss_cycle_A.item())
        losses_cycle_B_batch.append(Loss_cycle_B.item())

        Full_loss = Loss_GAN_B2A + Loss_GAN_A2B + Loss_cycle_A + Loss_cycle_B + loss_identity_B +loss_identity
        Full_loss.backward()
        optimizer_G.step()


        #opt D_A
        optimizer_D_A.zero_grad()
        pred_real_A = netD_A(A)
        real_loss_A = loss_GAN(pred_real_A, true_)
        pred_fake_A = netD_A(fake_A.detach())
        fake_loss_A = loss_GAN(pred_fake_A, false_)
        D_A_loss = (fake_loss_A +fake_loss_A)*0.5
        D_A_loss.backward()
        optimizer_D_A.step()
        losses_D_A_batch.append(D_A_loss.item())

        #opt D_B
        optimizer_D_B.zero_grad()
        pred_real_B = netD_B(B)
        real_loss_B = loss_GAN(pred_real_B, true_)
```

```
      pred_fake_B = netD_B(fake_B.detach())
      fake_loss_B = loss_GAN(pred_fake_B, false_)
      D_B_loss = (fake_loss_B +fake_loss_B)*0.5
      D_B_loss.backward()
      optimizer_D_B.step()
      losses_D_B_batch.append(D_B_loss.item())
      pbar.update(1)
      pbar.set_description("Epoch: {}".format(epoch))

    plt.figure(figsize=(24, 24));
    clear_output(wait=True);
    img_a, img_b = dataset[epoch]
    plt.subplot(2, 6, 1);
    plt.imshow(img_a.permute(2,1,0)*0.5+0.5);
    plt.title('Real_A');
    plt.axis('off');

    plt.subplot(2, 6, 2);
    fake_b = netG_A2B(img_a.unsqueeze(0).cuda()).cpu().detach()*0.5+0.5
    plt.imshow(fake_b.squeeze().permute(2,1,0));
    plt.title('A2B');
    plt.axis('off');
    plt.subplot(2, 6, 3);
    plt.imshow(img_b.permute(2,1,0)*0.5+0.5);
    plt.title('Real_B');
    plt.axis('off');
    plt.subplot(2, 6, 4);
    fake_a = netG_B2A(img_b.unsqueeze(0).cuda()).cpu().detach()*0.5+0.5
    plt.imshow(fake_a.squeeze().permute(2,1,0));
    plt.title('B2A');
    plt.axis('off');
    plt.show();



    losses_D_A.append(np.mean(losses_G_B2A_batch))
    losses_D_B.append(np.mean(losses_G_A2B_batch))
    losses_G_A2B.append(np.mean(losses_cycle_A_batch))
    losses_G_A2B.append(np.mean(losses_cycle_A_batch))
    losses_G_B2A.append(np.mean(losses_cycle_B_batch))
    losses_cycle_A.append(np.mean(losses_D_A_batch))
    losses_cycle_B.append(np.mean(losses_D_B_batch))
    lr_scheduler_G.step()
    lr_scheduler_D_A.step()
    lr_scheduler_D_B.step()
    pbar.close()


```

```
dataset = Dataset()
```

```
netG_A2B = Generator(3,3,6)
netG_B2A = Generator(3,3,6)
netD_A = Discriminator(3)
netD_B = Discriminator(3)
```

```
DEVICE = torch.device('cuda') if torch.cuda.is_available() else torch.device('cpu')
```

```
DEVICE
```

```
device(type='cuda')
```

```
data_loader = DataLoader(dataset)
```

```
netG_A2B.to(DEVICE);
netG_B2A.to(DEVICE);
netD_A.to(DEVICE);
netD_B.to(DEVICE);
```

```
loss_GAN = nn.MSELoss()
loss_cycle = nn.L1Loss()
loss_identity = nn.L1Loss()
loss_identity = nn.L1Loss()
```

```
optimizer_G = torch.optim.Adam(itertools.chain(netG_A2B.parameters(),netG_B2A.parameters()),lr=0.002)
optimizer_D_A = torch.optim.Adam(netD_A.parameters())
optimizer_D_B = torch.optim.Adam(netD_B.parameters())
```

```
num_epoch = 71
```

```
lr_scheduler_G = torch.optim.lr_scheduler.StepLR(optimizer_G, 40)
lr_scheduler_D_A = torch.optim.lr_scheduler.StepLR(optimizer_D_A, 40)
lr_scheduler_D_B = torch.optim.lr_scheduler.StepLR(optimizer_D_B, 40)
```

```
losses_D_A = []
losses_D_B = []
losses_G_A2B = []
losses_G_B2A = []
losses_cycle_A = []
losses_cycle_B = []
```

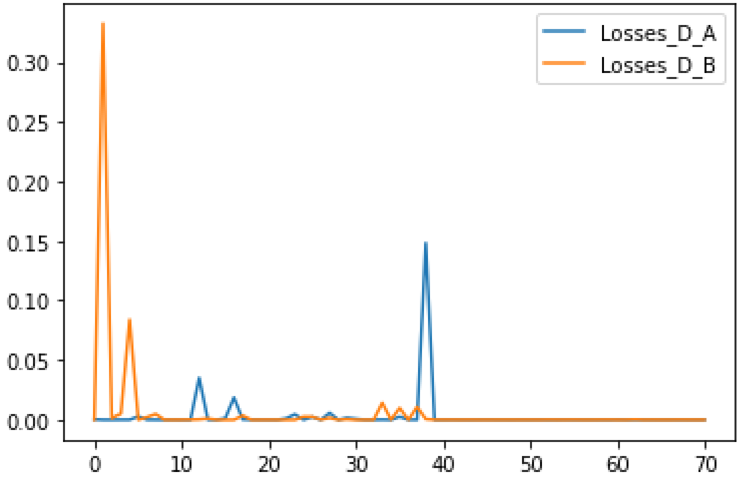
```
def save_weights():
  torch.save(netG_A2B.state_dict(),'NetG_A2B_71epoch')
  torch.save(netG_B2A.state_dict(),'NetG_B2A_71epoch')
  torch.save(netD_A.state_dict(),'D_A_71epoch')
  torch.save(netD_B.state_dict(),'D_B_71epoch')
```

```
train()
```

```
save_weights()
```

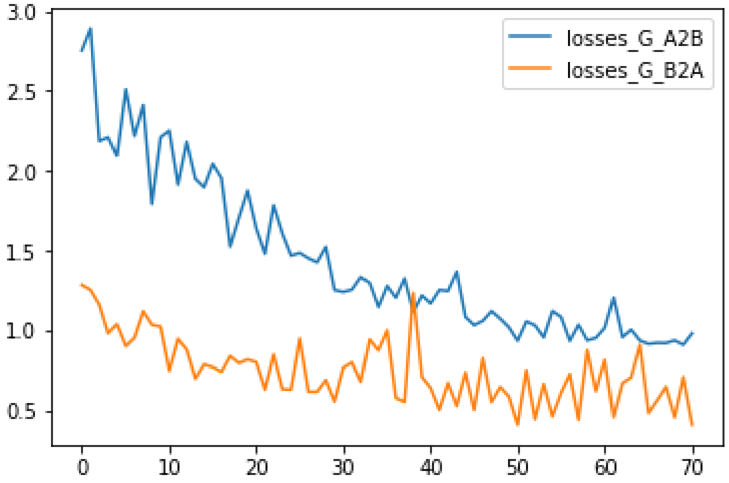
```
plt.plot(losses_D_A, label='Losses_D_A')
plt.plot(losses_D_B,label='Losses_D_B')
plt.legend()
```

```
<matplotlib.legend.Legend at 0x7f7b50b06d30>
```



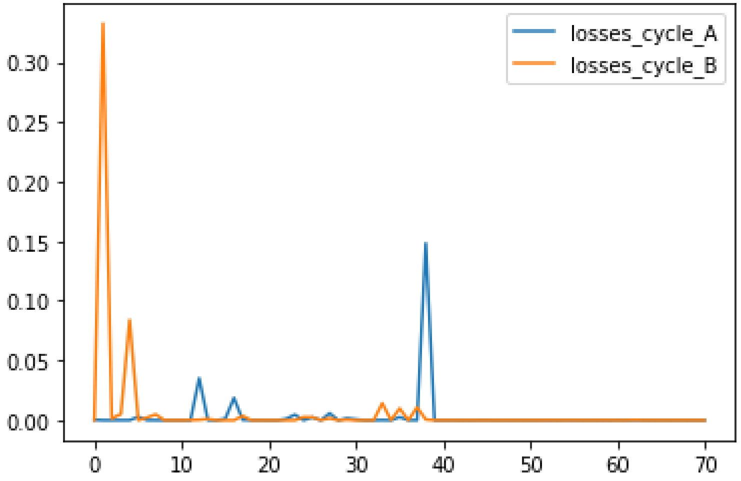
```
plt.plot(losses_G_A2B,label='losses_G_A2B')
plt.plot(losses_G_B2A,label='losses_G_B2A')
plt.legend()
```

```
<matplotlib.legend.Legend at 0x7f7b50baccc0>
```



```
plt.plot(losses_cycle_A,label='losses_cycle_A')
plt.plot(losses_cycle_B,label='losses_cycle_B')
plt.legend()
```

```
<matplotlib.legend.Legend at 0x7f7b50840828>
```



Результаты.

Один из генераторов научился менять цвет кожи лягушки на цвет кожи человека, получилось не плохо. Второй генератор меняет меняет оттенок кожи на зелёный (это было ожидаемо но не так интересно) продемонстрирую работу первого генератора

```
lass TestDataset(torch.utils.data.Dataset):
 def __init__(self):
   super().__init__()
   self.transforms  = transforms.Compose([
               transforms.Resize(256),
               transforms.ToTensor(),
               transforms.Normalize((0.5,0.5,0.5), (0.5,0.5,0.5))
   ]
   )
   self.files_A = sorted(os.path.join('/content/face2peepo/TrainA', i) for i in os.listdir('/content/face2pe
   self.files_B = sorted(os.path.join('/content/face2peepo/TrainB', i) for i in os.listdir('/content/face2pe
   self.files_A = list(filter(lambda x: Image.open(x).layers==3, self.files_A))
   self.files_B = list(filter(lambda x: Image.open(x).layers==3,self.files_B))
```

```

  def __getitem__(self,index):
    item_A = self.transforms(Image.open(self.files_A[index % len(self.files_A)]))
    item_B = self.transforms(Image.open(self.files_B[index % len(self.files_B)]))
    return item_A, item_B

  def __len__(self):
    return max(len(self.files_A), len(self.files_B))
```

```
data = TestDataset()
A1, B = data[10]
A2, B = data[3]
A3, B = data[4]
A4, B = data[44]
```

```
plt.imshow(A1.permute(1,2,0)*0.5+0.5)
plt.title('Real A')
plt.axis('off')
```

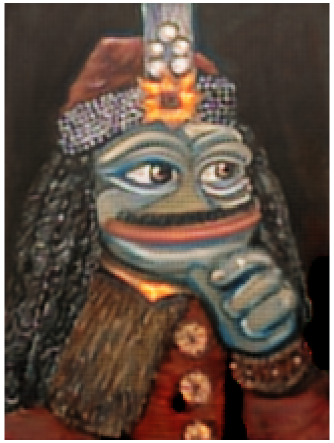
```
(-0.5, 255.5, 343.5, -0.5)
```

Real A

```
fake_B = netG_A2B(A1.unsqueeze(0).cuda())*0.5+0.5
plt.imshow(fake_B.squeeze().permute(1,2,0).cpu().detach())
plt.imshow(fake_B.squeeze().permute(1,2,0).cpu().detach())
plt.title('Fake B')
plt.axis('off')
```

```
(-0.5, 255.5, 343.5, -0.5)
```

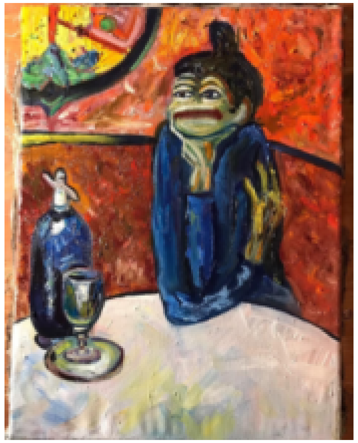
Fake B



```
plt.imshow(A2.permute(1,2,0)*0.5+0.5)
plt.title('Real A')
plt.axis('off')
```

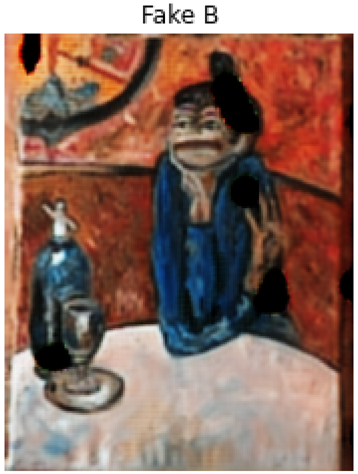
```
(-0.5, 255.5, 319.5, -0.5)
```

Real A



```
fake_B = netG_A2B(A2.unsqueeze(0).cuda())*0.5+0.5
plt.imshow(fake_B.squeeze().permute(1,2,0).cpu().detach())
plt.title('Fake B')
plt.axis('off')
```

```
(-0.5, 255.5, 319.5, -0.5)
```



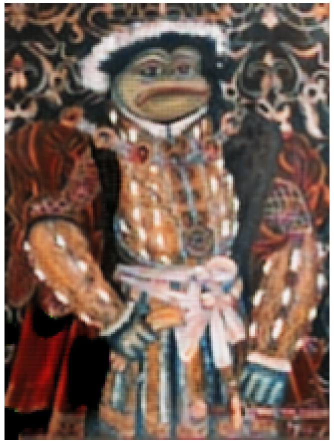
```
plt.imshow(A3.permute(1,2,0)*0.5+0.5)
plt.title('Real A')
plt.axis('off')
```

```
(-0.5, 255.5, 341.5, -0.5)
```

Real A

```
fake_B = netG_A2B(A3.unsqueeze(0).cuda())*0.5+0.5
plt.imshow(fake_B.squeeze().permute(1,2,0).cpu().detach())
plt.title('Fake B')
plt.axis('off')
```

```
(-0.5, 255.5, 343.5, -0.5)
```



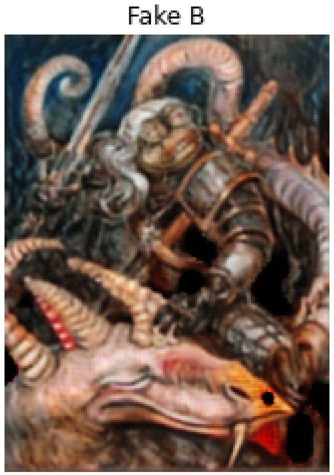
Fake B

```
plt.imshow(A4.permute(1,2,0)*0.5+0.5)
plt.title('Real A')
plt.axis('off')
```

```
(-0.5, 255.5, 340.5, -0.5)
```

```
fake_B = netG_A2B(A4.unsqueeze(0).cuda())*0.5+0.5
plt.imshow(fake_B.squeeze().permute(1,2,0).cpu().detach())
plt.title('Fake B')
plt.axis('off')
```

```
(-0.5, 255.5, 343.5, -0.5)
```

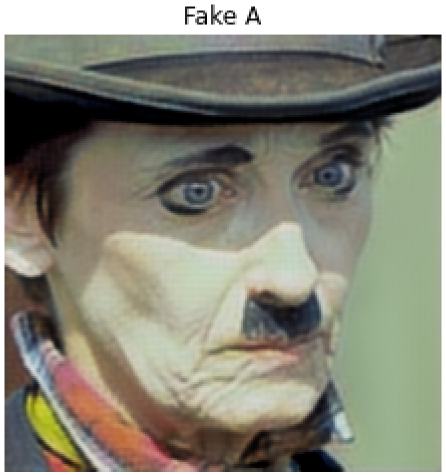


```
plt.imshow(B.permute(1,2,0)*0.5+0.5)
plt.title('Real B')
plt.axis('off')
```

```
(-0.5, 255.5, 255.5, -0.5)
```

```
fake_A = netG_B2A(B.unsqueeze(0).cuda())*0.5+0.5
plt.imshow(fake_A.squeeze().permute(1,2,0).cpu().detach())
plt.title('Fake A')
plt.axis('off')
```

```
(-0.5, 255.5, 255.5, -0.5)
```



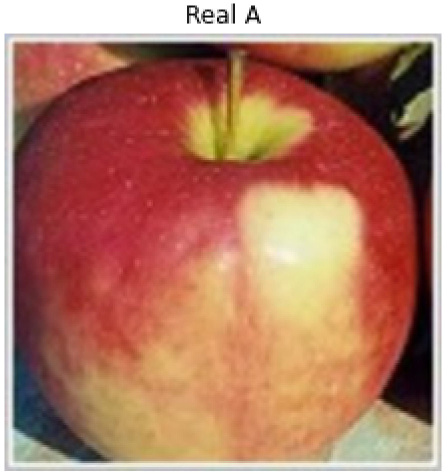
```
assert StopIteration
```

Проверка модели и цила обучения на стандартных данных

epoch = 14 n_blocks = 6

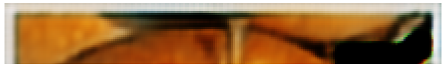
```
plt.imshow(A.permute(1,2,0)*0.5+0.5)
plt.title('Real A')
plt.axis('off')
```

```
(-0.5, 255.5, 255.5, -0.5)
```



```
fake_B = netG_A2B(A.unsqueeze(0).cuda())*0.5+0.5
plt.imshow(fake_B.squeeze().permute(1,2,0).cpu().detach())
plt.title('Fake B')
plt.axis('off')
```

```
(-0.5, 255.5, 255.5, -0.5)
```



Fake B

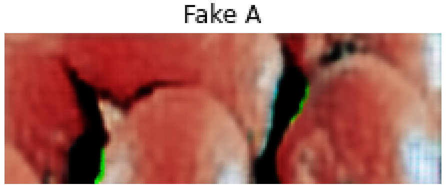
```
plt.imshow(B.permute(1,2,0)*0.5+0.5)
plt.title('Real B')
plt.axis('off')
```

```
(-0.5, 255.5, 255.5, -0.5)
```

Real B

```
fake_A = netG_B2A(B.unsqueeze(0).cuda())*0.5+0.5
plt.imshow(fake_A.squeeze().permute(1,2,0).cpu().detach())
plt.title('Fake A')
plt.axis('off')
```

```
(-0.5, 255.5, 255.5, -0.5)
```



Видно что всё работает как и планировалось