Нейронный перенос стиля с Pytorch

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Введение

В этом ноутбуке объясняется и показывается, как работает алгоритм переноса стиля

Neural-Style <https://arxiv.org/abs/1508.06576>

Леона А. Гатиса, Александра С. Эккера и Маттиаса Бетге.

Нейронный перенос стиля -- это алгоритм, который принимает контент-изображение (напр
(например, картинку известного художника) и возвращает изображение, которое будто бы

Как это работает?

Всего есть три картинки: вход, стиль и контент. Определим два расстояния:

- D_S - оно определяет на сколько разные стили у двух произвольных картинок.
- D_C - оно определяет на сколько разнится контент у двух произвольных картинок.

задача сети - минимизировать D_S от входной картинки до стиля и D_C от входной картини
В качестве входа обычно берется зашумленная к артинка контента.

Это все что нам понадобится:

```
1 !pip3 install torch torchvision
2 #!pip3 install pillow==4.1.1
```

```
Requirement already satisfied: torch in /usr/local/lib/python3.6/dist-packages (1.5.0
Requirement already satisfied: torchvision in /usr/local/lib/python3.6/dist-packages
Requirement already satisfied: future in /usr/local/lib/python3.6/dist-packages (from
Requirement already satisfied: numpy in /usr/local/lib/python3.6/dist-packages (from
Requirement already satisfied: pillow>=4.1.1 in /usr/local/lib/python3.6/dist-package
```

```
1 !wget https://www.dropbox.com/s/afqhab9zc9r8otb/images.zip?dl=1
2 !mv images.zip?dl=1 images.zip
3 !unzip images.zip
```

```
--2020-06-08 12:38:43--  https://www.dropbox.com/s/afqhab9zc9r8otb/images.zip?dl=1
Resolving www.dropbox.com (www.dropbox.com)... 162.125.67.1, 2620:100:6023:1::a27d:43
Connecting to www.dropbox.com (www.dropbox.com)|162.125.67.1|:443... connected.
HTTP request sent, awaiting response... 301 Moved Permanently
Location: /s/dl/afqhab9zc9r8otb/images.zip [following]
--2020-06-08 12:38:44--  https://www.dropbox.com/s/dl/afqhab9zc9r8otb/images.zip
Reusing existing connection to www.dropbox.com:443.
HTTP request sent, awaiting response... 302 Found
Location: https://uc2837e4903a11abfc58eba6f62d.dl.dropboxusercontent.com/cd/0/get/A5F
--2020-06-08 12:38:44--  https://uc2837e4903a11abfc58eba6f62d.dl.dropboxusercontent.c
Resolving uc2837e4903a11abfc58eba6f62d.dl.dropboxusercontent.com (uc2837e4903a11abfc5
Connecting to uc2837e4903a11abfc58eba6f62d.dl.dropboxusercontent.com (uc2837e4903a11a
HTTP request sent, awaiting response... 200 OK
Length: 1057322 (1.0M) [application/binary]
Saving to: ‘images.zip?dl=1’
```

```
%matplotlib inline
from PIL import Image


import torch
import torch.nn as nn
import torch.nn.functional as F
import torch.optim as optim

import matplotlib.pyplot as plt


import torchvision.transforms as transforms
import torchvision.models as models

import copy
```

```
!ls images/
```

```
content.jpg  first_style.jpg  second_style.jpg
```

Загрузка изображений

Нам понадобятся картинки стиля и контента, так что загрузим их.
Чтобы упростить реализацию, начнем с контента и стиля одного размера. Затем мы масш
выходного изображения.

Примеры изображений лежат в папке `Images` на гуглдиске

Вы можете добавить туда свои собственные изображения -- главное, чтобы они были одно

```
imsize = 512

loader = transforms.Compose([
    transforms.Resize(imsize),  # нормируем размер изображения
    transforms.CenterCrop(imsize),
    transforms.ToTensor()])  # превращаем в удобный формат
```

```
device = torch.device("cuda" if torch.cuda.is_available() else "cpu")
def image_loader(image_name):
    image = Image.open(image_name)
    image = loader(image).unsqueeze(0)
    return image.to(device, torch.float)


#content_img = image_loader("images/picasso.jpg")# as well as here
#style_img = image_loader("images/lisa.jpg")#измените путь на тот который у вас.
#style_img = image_loader("images/picasso.jpg")# as well as here
#style_img_second = image_loader("images/second.jpg")# as well as here
#content_img = image_loader("images/lisa.jpg")#измените путь на тот который у вас.
```

```
#!wget https://museum-design.ru/wp-content/uploads/i-scott-05.jpg -O /content/images/fi
# ТУТ КРАСНЫЙ КВАДРАТ
#!wget https://art-holst.com.ua/wp-content/uploads/thumb_l_28551.jpg -O /content/images
#!wget https://storge.pic2.me/c/1360x800/721/59aea1186a1bf.jpg -O /content/images/conte

#!wget https://vestikavkaza.ru/upload/2019-12-18/15767022705dfa913e619de3.24454359.jpg
```

```
--2020-06-08 10:41:40--  https://museum-design.ru/wp-content/uploads/i-scott-05.jpg
Resolving museum-design.ru (museum-design.ru)... 5.9.57.100
Connecting to museum-design.ru (museum-design.ru)|5.9.57.100|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 561477 (548K) [image/jpeg]
Saving to: ‘/content/images/first_style.jpg’

/content/images/fir 100%[===================>] 548.32K  --.-KB/s    in 0.1s
```

```
1
```

```
--2020-06-08 10:41:43--  https://art-holst.com.ua/wp-content/uploads/thumb_l_28551.jp
```

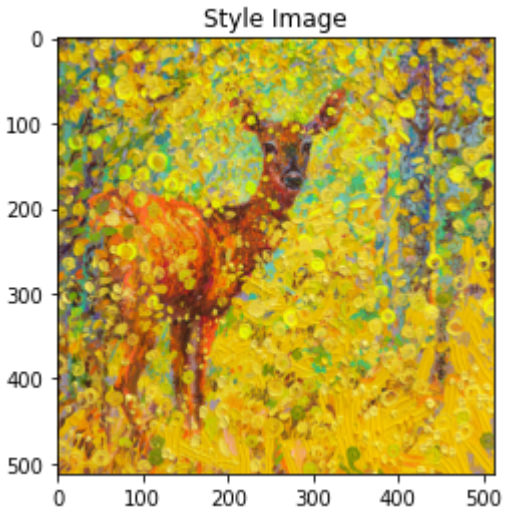
```
#content_img = image_loader("images/picasso.jpg")# as well as here
#style_img = image_loader("images/lisa.jpg")#измените путь на тот который у вас.
style_img = image_loader("images/first_style.jpg")# as well as here
style_img_second = image_loader("images/second_style.jpg")# as well as here
content_img = image_loader("images/content.jpg")#измените путь на тот который у вас.
```

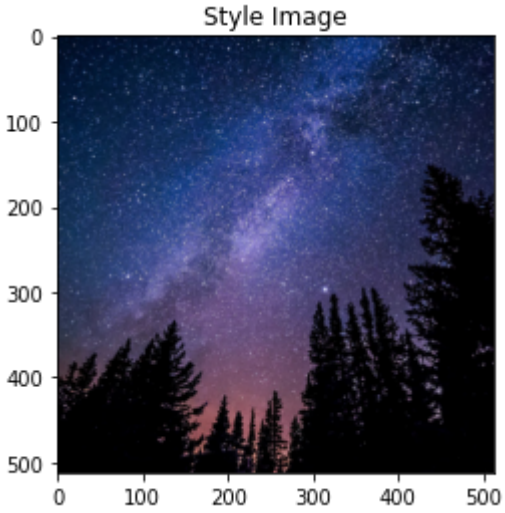
```
/content/images/sec 100%[===================>] 129.50K  --.-KB/s    in 0.01s
```

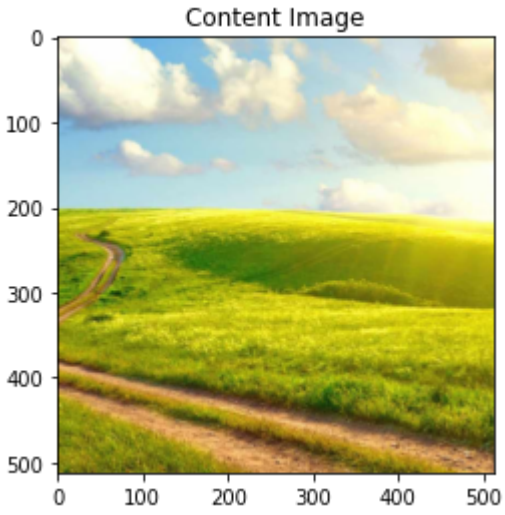
Выведем то, что было загружено

```
--2020-06-08 10:41:45--  https://storage.pic2.me/c/1360x800/721/59aea1186a1bf.jpg
```

```
unloader = transforms.ToPILImage() # тензор в кратинку

plt.ion()

def imshow(tensor, title=None):
    image = tensor.cpu().clone()
    image = image.squeeze(0)      # функция для отрисовки изображения
    image = unloader(image)
    plt.imshow(image)
    if title is not None:
        plt.title(title)
    plt.pause(0.001)

def tensor_to_matrix(tensor):
    # plt.figure(figsize=(10,10))
    image = tensor.cpu().clone()
    image = image.squeeze(0)      # функция для отрисовки изображения
    image = unloader(image)
    return image

# отрисовка

plt.figure()
imshow(style_img, title='Style Image')

plt.figure()
imshow(style_img_second, title='Style Image')


plt.figure()
imshow(content_img, title='Content Image')

```







Теперь нужно создать функции, которые будут вычислять расстояния (D_C и D_S). Они будут выполенены в виде слоев, чтобы брать по ним автоградиент.

D_S - средняя квадратичная ощибка input'a и target'a

```
class ContentLoss(nn.Module):

        def __init__(self, target,):
            super(ContentLoss, self).__init__()
            # we 'detach' the target content from the tree used
            # to dynamically compute the gradient: this is a stated value,
```

```
            # to dynamically compute the gradient: this is a stated value,
            # not a variable. Otherwise the forward method of the criterion
            # will throw an error.
            self.target = target.detach()#это константа. Убираем ее из дерева вычислени
            self.loss = F.mse_loss(self.target, self.target )#to initialize with someth

        def forward(self, input):
            self.loss = F.mse_loss(input, self.target)
            return input
```

Матрица грама позволяет учесть не только сами значения feature map'a, но и кореляцию ф
Это нужно для того, чтобы сделать акцент на встречаемость фич с друг другом, а не на их
Полное понимание этого момента можно получить с помощью этого и этого.

Таким образом:

$D_S = \sum(G_{ij}(img_1) - G_{ij}(img_2))^2$

Сначала задаем спрособ подсчета матрицы грама: Это просто тензорное тензорное произ
себя.
Однка наш выход - не вектор. В этом случае операция тоже возможна,
но мы получим тензор третьего ранга. Поэтому перед перемножением выход нужно приве

```
def gram_matrix(input):
        batch_size , f_map_num, h, w = input.size()  # batch size(=1)
        #print("gram_matrix =" , batch_size, f_map_num, h, w)
        # b=number of feature maps
        # (h,w)=dimensions of a feature map (N=h*w)

        features = input.view(batch_size * f_map_num, w * h)  # resise F_XL into \hat F

        G = torch.mm(features, features.t())  # compute the gram product

        # we 'normalize' the values of the gram matrix
        # by dividing by the number of element in each feature maps.
        return G.div(batch_size * h * w * f_map_num)
```

Матрица грама готова, теперь нужно лишь реализовать MSE

```

```

```
class StyleLoss(nn.Module):
        def __init__(self, target_feature):
            super(StyleLoss, self).__init__()
            self.target = gram_matrix(target_feature).detach()
            self.loss = F.mse_loss(self.target, self.target)# to initialize with someth

        def forward(self, input):
            G = gram_matrix(input)
```

```
            self.loss = F.mse_loss(G, self.target)
            return input
```

При тренировке VGG каждое изображение на котором она обучалась было нормировано п
использовать ее для нашей модели, то мы должны реализовать нормировку и для наших

```
cnn_normalization_mean = torch.tensor([0.485, 0.456, 0.406]).to(device)
cnn_normalization_std = torch.tensor([0.229, 0.224, 0.225]).to(device)
```

```
class Normalization(nn.Module):
        def __init__(self, mean, std):
            super(Normalization, self).__init__()
            # .view the mean and std to make them [C x 1 x 1] so that they can
            # directly work with image Tensor of shape [B x C x H x W].
            # B is batch size. C is number of channels. H is height and W is width.
            self.mean = torch.tensor(mean).view(-1, 1, 1)
            self.std = torch.tensor(std).view(-1, 1, 1)

        def forward(self, img):
            # normalize img
            return (img - self.mean) / self.std
```

Теперь соберем это все в одну функцию, которая отдаст на выходе модель и две функции

Определим после каких уровней мы будем счиатать ошибки стиля, а после каких ошибки

```
content_layers_default = ['conv_4']
style_layers_default = ['conv_1', 'conv_2', 'conv_3', 'conv_4', 'conv_5']
```

Определим предобученную модель

```
cnn = models.vgg19(pretrained=True).features.to(device).eval()
```

```
Downloading: "https://download.pytorch.org/models/vgg19-dcbb9e9d.pth" to /root/.cache
100%                                548M/548M [00:29<00:00, 19.5MB/s]
```

```
def get_style_model_and_losses(cnn, normalization_mean, normalization_std,
                               style_img, style_img_second, content_img,
                               content_layers=content_layers_default,
                               style_layers=style_layers_default):
        cnn = copy.deepcopy(cnn)

        # normalization module
        normalization = Normalization(normalization_mean, normalization_std).to(device)

        # just in order to have an iterable access to or list of content/syle
```

```
    # losses
    content_losses = []
    style_losses = []
    style_losses_second = []

    # assuming that cnn is a nn.Sequential, so we make a new nn.Sequential
    # to put in modules that are supposed to be activated sequentially
    model = nn.Sequential(normalization)

    i = 0  # increment every time we see a conv
    for layer in cnn.children():
        if isinstance(layer, nn.Conv2d):
            i += 1
            name = 'conv_{}'.format(i)
        elif isinstance(layer, nn.ReLU):
            name = 'relu_{}'.format(i)
            # The in-place version doesn't play very nicely with the ContentLoss
            # and StyleLoss we insert below. So we replace with out-of-place
            # ones here.
            #Переопределим relu уровень
            layer = nn.ReLU(inplace=False)
        elif isinstance(layer, nn.MaxPool2d):
            name = 'pool_{}'.format(i)
        elif isinstance(layer, nn.BatchNorm2d):
            name = 'bn_{}'.format(i)
        else:
            raise RuntimeError('Unrecognized layer: {}'.format(layer.__class__.__na

        model.add_module(name, layer)

        if name in content_layers:
            # add content loss:
            target = model(content_img).detach()
            content_loss = ContentLoss(target)
            model.add_module("content_loss_{}".format(i), content_loss)
            content_losses.append(content_loss)

        if name in style_layers:
            # add style loss:
            target_feature = model(style_img).detach()
            style_loss = StyleLoss(target_feature)
            model.add_module("style_loss_{}".format(i), style_loss)
            style_losses.append(style_loss)

            # add style loss:
            target_feature_second = model(style_img_second).detach()
            style_loss_second = StyleLoss(target_feature_second)
            model.add_module("style_loss_second_{}".format(i), style_loss_second)
            style_losses_second.append(style_loss_second)

    # now we trim off the layers after the last content and style losses
    #выбрасываем все уровни после последенего styel loss или content loss
    for i in range(len(model) - 1, -1, -1):
        if isinstance(model[i], ContentLoss) or isinstance(model[i], StyleLoss):
            break
```

```
66
67         model = model[:(i + 1)]
68
69         return model, style_losses, style_losses_second, content_losses
```

```
1 def get_input_optimizer(input_img):
2         # this line to show that input is a parameter that requires a gradient
3         #добоваляет содержимое тензора катринки в список изменяемых оптимизатором парам
4         #optimizer = optim.LBFGS([input_img.requires_grad_()])
5         #optimizer = optim.LBFGS([input_img.requires_grad_()])
6         optimizer = torch.optim.Adam([input_img.requires_grad_()])
7         return optimizer
```

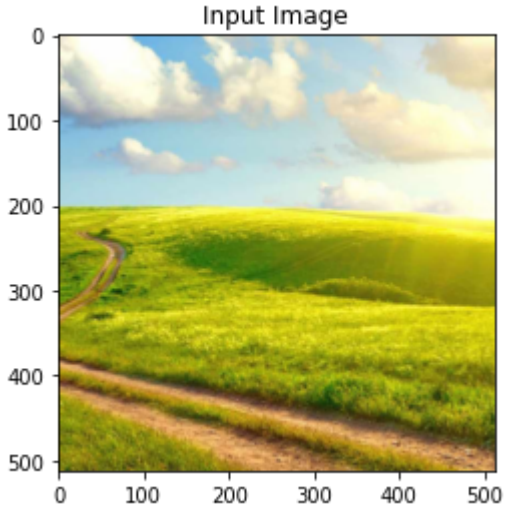
```
1
```

Дальше стандартный цикл обучения, но что это за closure?
Это функция, которая вызывается во время каждого прохода, чтобы пересчитать loss. Без функция ошибки

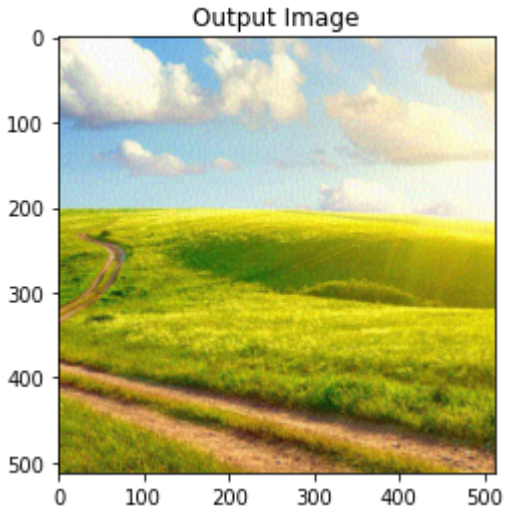
```
1 def run_style_transfer(cnn, normalization_mean, normalization_std,
2                         content_img, style_img, style_img_second, input_img, num_steps=
3                         style_weight=100000, content_weight=1, alpha_coefficient=0.1):
4                         #style_weight=1, content_weight=100000):
5         """Run the style transfer."""
6         print('Building the style transfer model..')
7         model, style_losses, style_losses_second, content_losses = get_style_model_and_
8             normalization_mean, normalization_std, style_img, style_img_second, content
9         optimizer = get_input_optimizer(input_img)
10
11
12        print('Optimizing..')
13        run = [0]
14        while run[0] <= num_steps:
15
16            def closure():
17                # correct the values
18                # это для того, чтобы значения тензора картинки не выходили за пределы
19                input_img.data.clamp_(0, 1)
20
21                optimizer.zero_grad()
22
23                model(input_img)
24
25                style_score = 0
26                style_score_second = 0
27                content_score = 0
28
29                for sl in style_losses:
30                    style_score += sl.loss
31                for sl_second in style_losses_second:
32                    style_score_second += sl_second.loss
33                for cl in content_losses:
```

```
                for cl in content_losses:
                    content_score += cl.loss


                #взвешивание ощибки
                style_score *= (style_weight * (1 - alpha_coefficient))
                style_score_second *= (style_weight * alpha_coefficient)
                content_score *= content_weight

                loss = style_score + style_score_second + content_score
                loss.backward()

                run[0] += 1
                if run[0] % 50 == 0:
                    print("run {}:".format(run))
                    print('Style Loss : {:4f} Style-Second Loss : {:4f} Content Loss: {
                        style_score.item(), style_score_second.item(), content_score.it
                    print()
                    plt.figure()
                    imshow(input_img, title='Output Image')
                    plt.ioff()
                    plt.show()

                return style_score + style_score_second + content_score

            optimizer.step(closure)

        # a last correction...
        input_img.data.clamp_(0, 1)

        return input_img
```

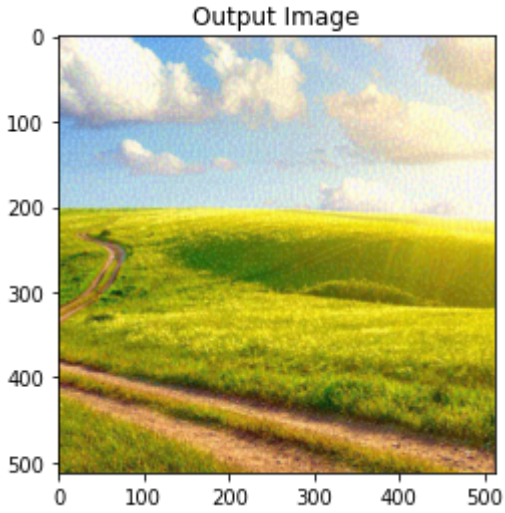
```
input_img = content_img.clone()
# if you want to use white noise instead uncomment the below line:
#input_img = torch.randn(content_img.data.size(), device=device)

# add the original input image to the figure:
plt.figure()
imshow(input_img, title='Input Image')
output = run_style_transfer(cnn, cnn_normalization_mean, cnn_normalization_std,
                            content_img, style_img, style_img_second, input_img, alpha_

plt.figure()
imshow(output, title='Output Image')
#plt.imsave(output, 'output.png')
# sphinx_gallery_thumbnail_number = 4
plt.ioff()
plt.show()
```



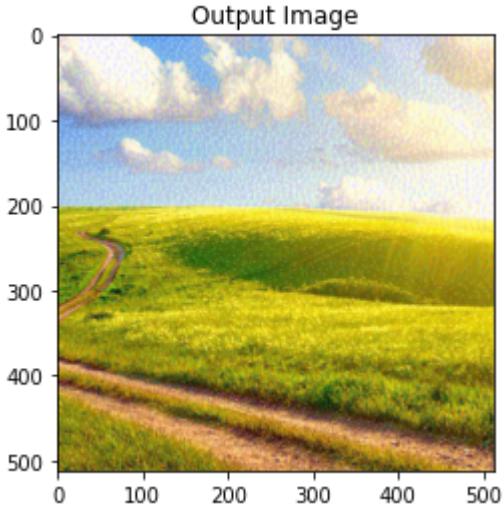

```
Building the style transfer model..
Optimizing..
/usr/local/lib/python3.6/dist-packages/ipykernel_launcher.py:7: UserWarning: To copy
  import sys
/usr/local/lib/python3.6/dist-packages/ipykernel_launcher.py:8: UserWarning: To copy

run [50]:
Style Loss : 1385.941162 Style-Second Loss : 991.702942 Content Loss: 8.912428
```



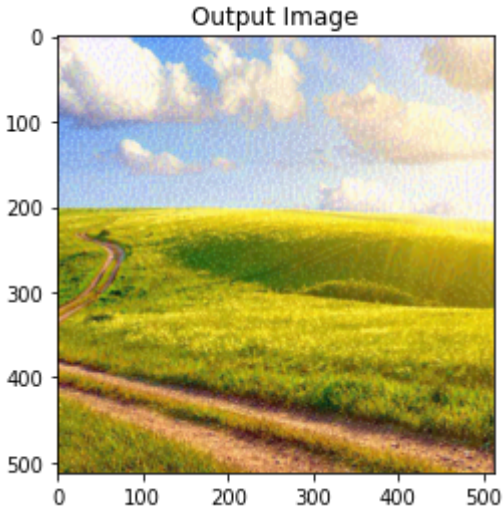

```
run [100]:
Style Loss : 1323.689087 Style-Second Loss : 900.548035 Content Loss: 11.816435
```



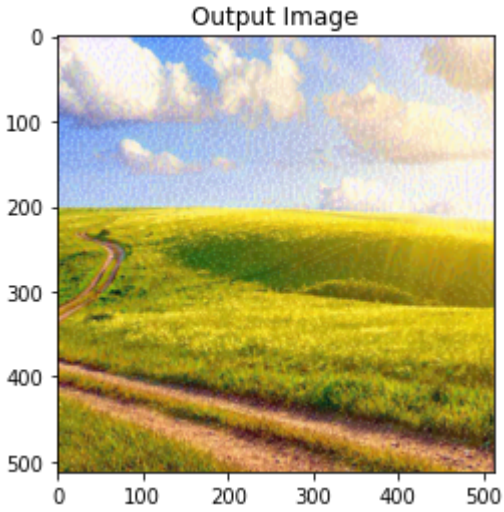

```
run [150]:
Style Loss : 1316.747070 Style-Second Loss : 836.502747 Content Loss: 13.192642
```



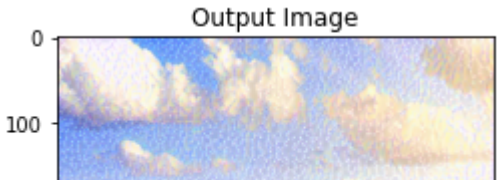

```
run [200]:
Style Loss : 1317.272339 Style-Second Loss : 793.015808 Content Loss: 14.105225
```

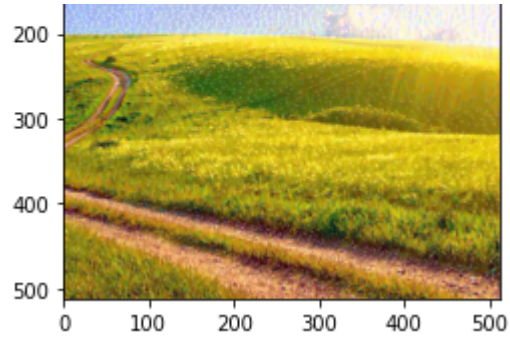



```
run [250]:
Style Loss : 1320.058350 Style-Second Loss : 761.951172 Content Loss: 14.747772
```

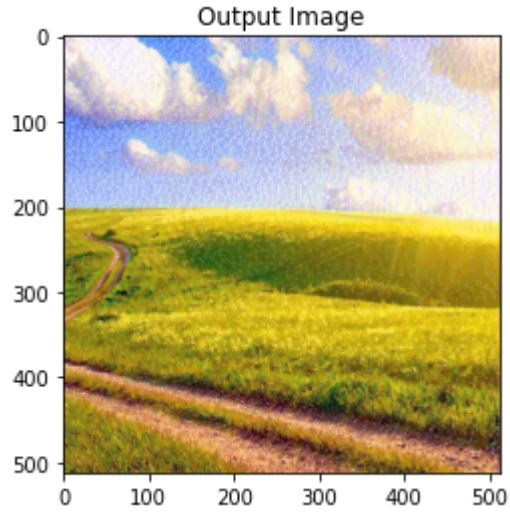



```
run [300]:
Style Loss : 1323.468750 Style-Second Loss : 738.644165 Content Loss: 15.224835
```

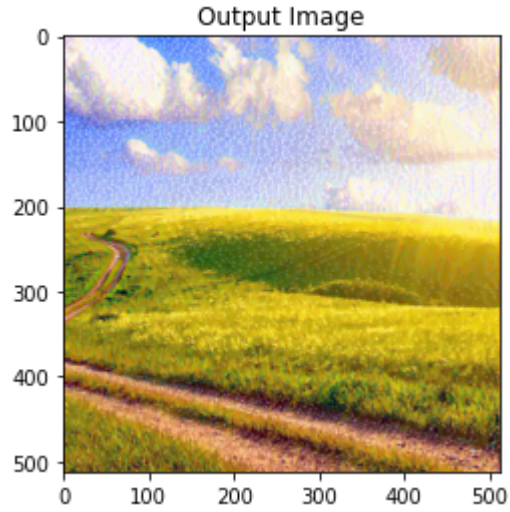




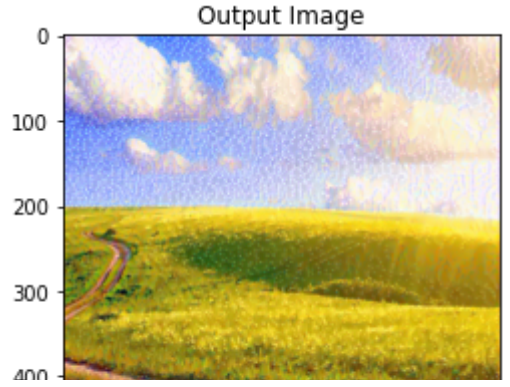

```
run [350]:
Style Loss : 1327.009888 Style-Second Loss : 720.307129 Content Loss: 15.594793
```

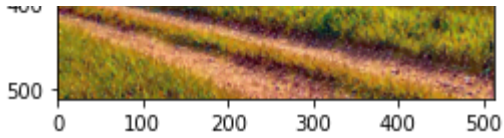



```
run [400]:
Style Loss : 1330.464233 Style-Second Loss : 705.446411 Content Loss: 15.890959
```

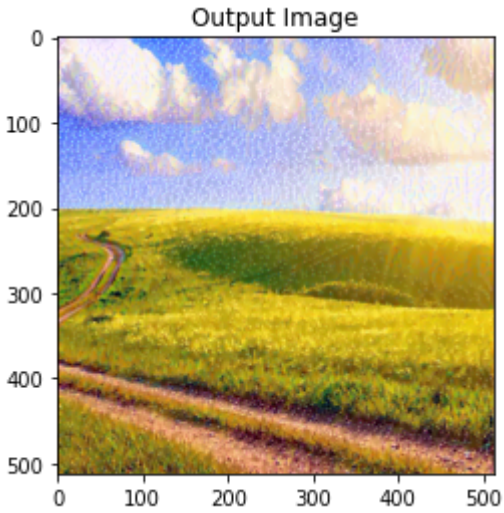


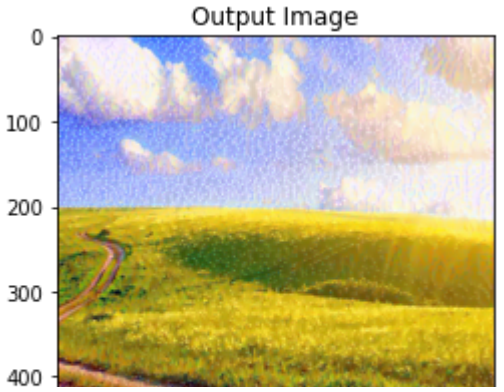

```
run [450]:
Style Loss : 1333.833252 Style-Second Loss : 693.079529 Content Loss: 16.129791
```





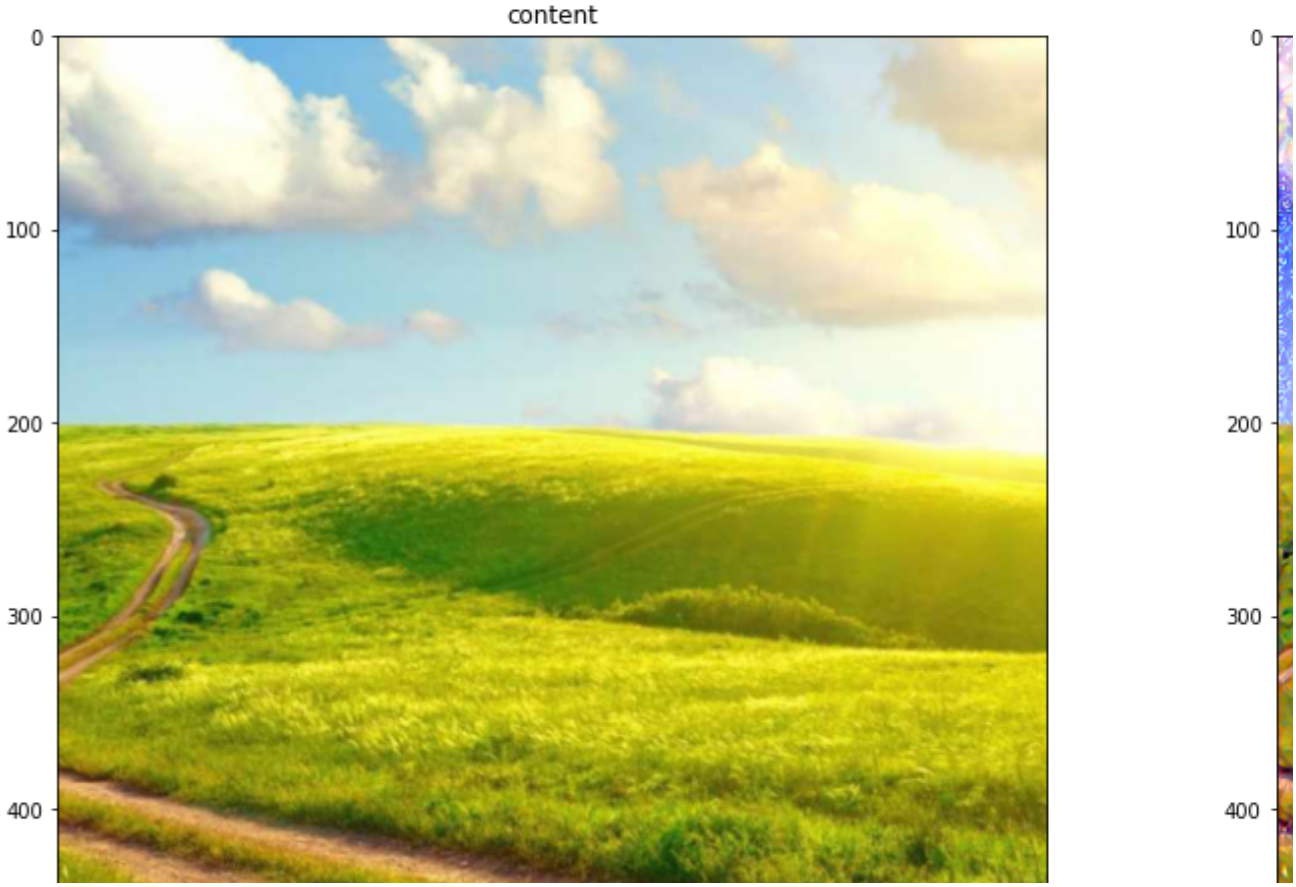

```
run [500]:
Style Loss : 1337.081299 Style-Second Loss : 682.613037 Content Loss: 16.322048
```



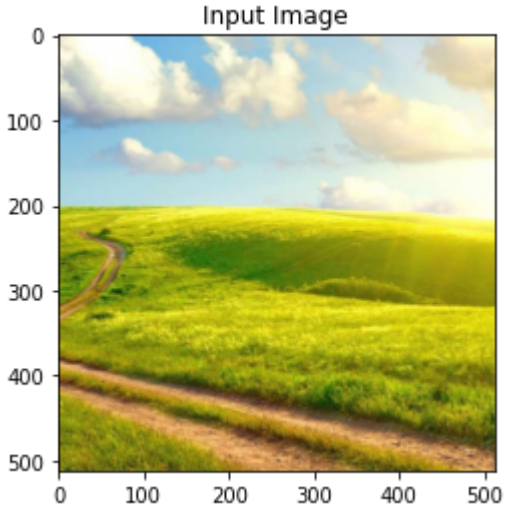



```
fig = plt.figure(figsize=(20,20), )

plt.subplot(2, 2, 1)
plt.title('style 1')
plt.imshow(tensor_to_matrix(style_img))

plt.subplot(2, 2, 2)
plt.title('style second')
plt.imshow(tensor_to_matrix(style_img_second))

plt.subplot(2, 2, 3)
plt.title('content')
plt.imshow(tensor_to_matrix(content_img))

plt.subplot(2, 2, 4)
plt.title('outout')
plt.imshow(tensor_to_matrix(output))


plt.ioff()
plt.show()
```

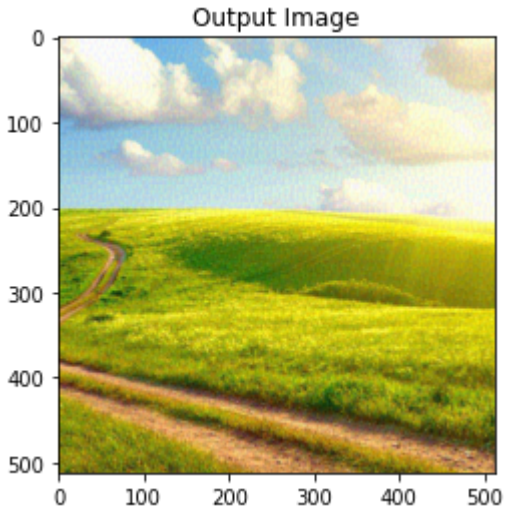

style 1
0
100
200
300
400
500


content
0
100
200
300
400

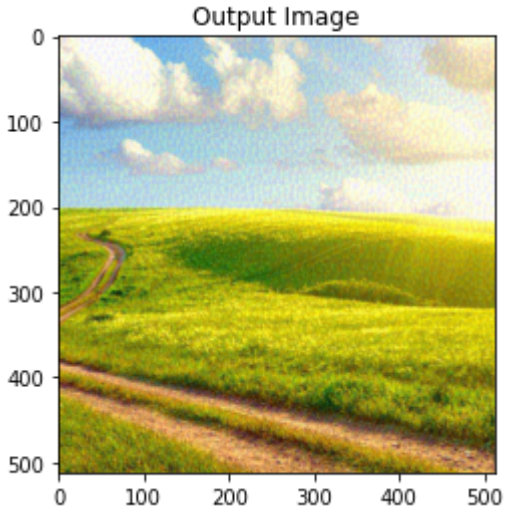

```
input_img = content_img.clone()
# if you want to use white noise instead uncomment the below line:
#input_img = torch.randn(content_img.data.size(), device=device)

# add the original input image to the figure:
plt.figure()
imshow(input_img, title='Input Image')
output = run_style_transfer(cnn, cnn_normalization_mean, cnn_normalization_std,
                            content_img, style_img, style_img_second, input_img, alpha_

plt.figure()
imshow(output, title='Output Image')
#plt.imsave(output, 'output.png')
# sphinx_gallery_thumbnail_number = 4
plt.ioff()
plt.show()
```



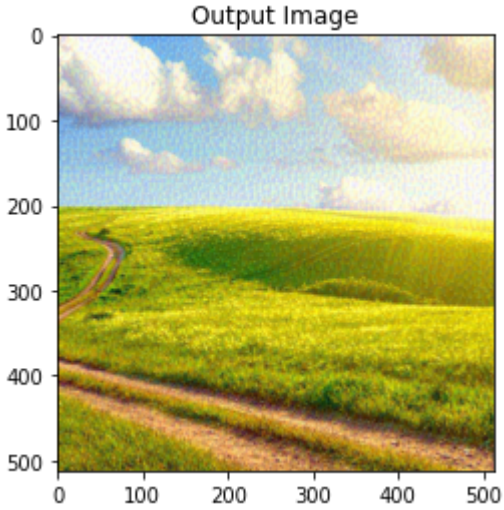

```
Building the style transfer model..
Optimizing..
/usr/local/lib/python3.6/dist-packages/ipykernel_launcher.py:7: UserWarning: To copy
  import sys
/usr/local/lib/python3.6/dist-packages/ipykernel_launcher.py:8: UserWarning: To copy

run [50]:
Style Loss : 1407.555054 Style-Second Loss : 1372.163330 Content Loss: 10.413445
```



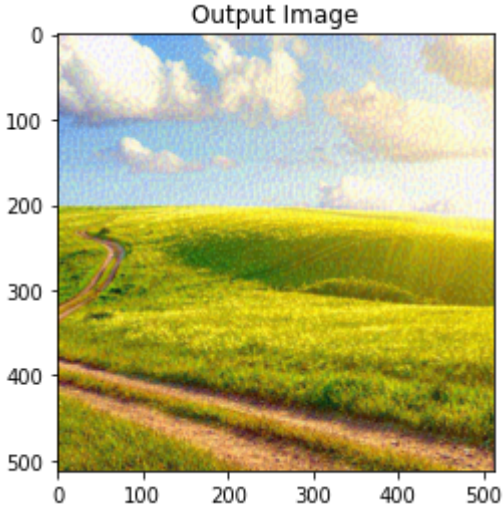

```
run [100]:
Style Loss : 1225.127075 Style-Second Loss : 1351.886108 Content Loss: 14.330048
```



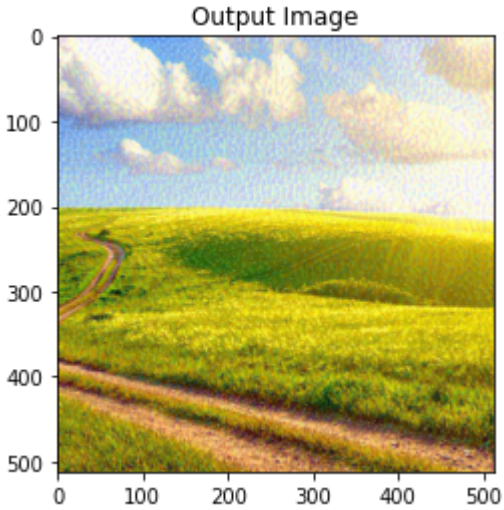

```
run [150]:
Style Loss : 1185.430664 Style-Second Loss : 1324.331177 Content Loss: 15.677208
```



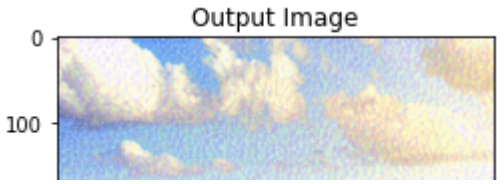

```
run [200]:
Style Loss : 1167.370728 Style-Second Loss : 1301.530151 Content Loss: 16.625723
```

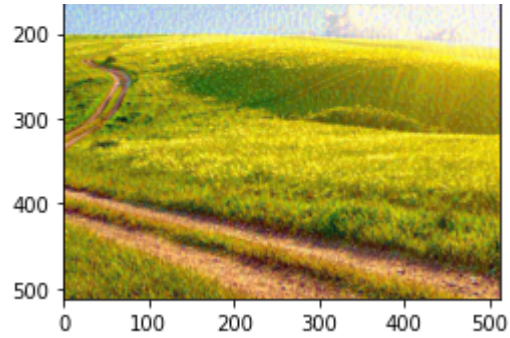



```
run [250]:
Style Loss : 1157.950439 Style-Second Loss : 1283.749390 Content Loss: 17.306702
```

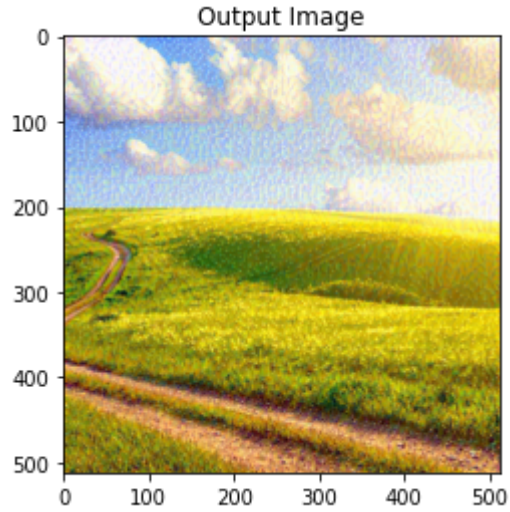



```
run [300]:
Style Loss : 1153.011719 Style-Second Loss : 1269.721191 Content Loss: 17.807995
```

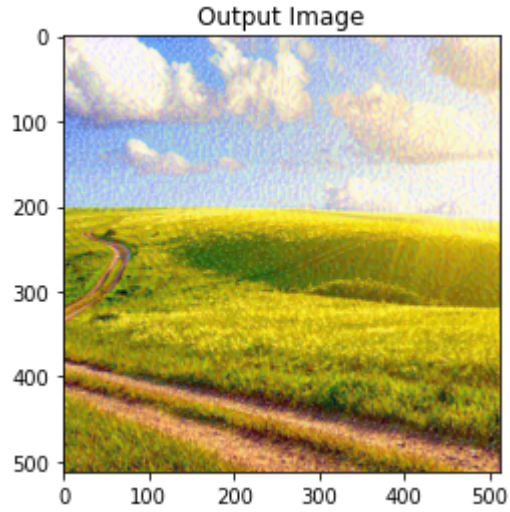




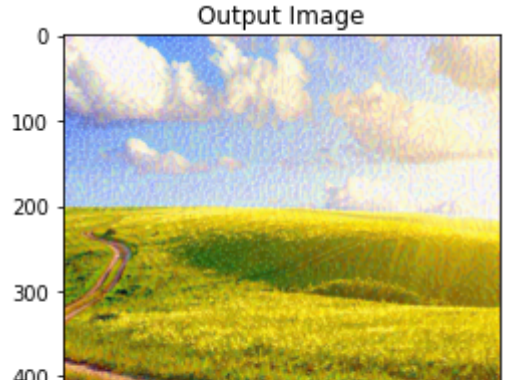
```
run [350]:
Style Loss : 1150.686768 Style-Second Loss : 1258.341431 Content Loss: 18.183350
```

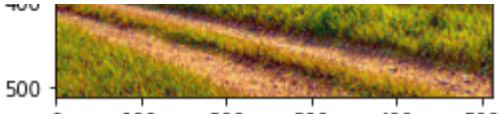



```
run [400]:
Style Loss : 1149.900513 Style-Second Loss : 1248.874390 Content Loss: 18.467407
```



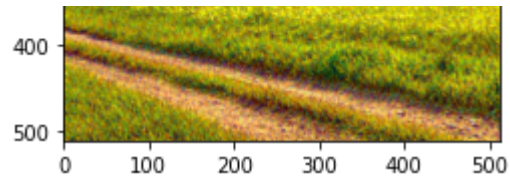

```
run [450]:
Style Loss : 1149.979736 Style-Second Loss : 1240.857910 Content Loss: 18.684111
```



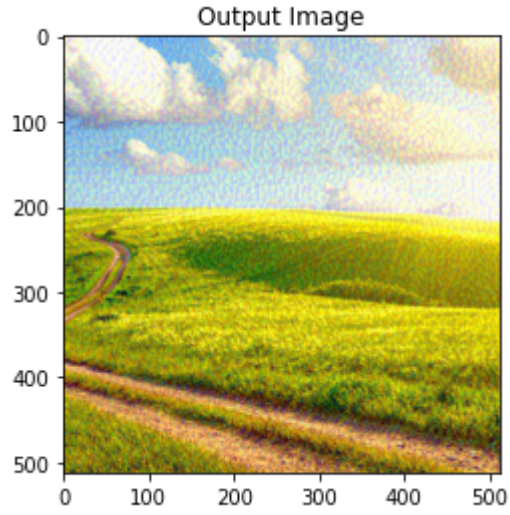



```
fig = plt.figure(figsize=(20,20), )

plt.subplot(2, 2, 1)
plt.title('style 1')
plt.imshow(tensor_to_matrix(style_img))

plt.subplot(2, 2, 2)
plt.title('style second')
plt.imshow(tensor_to_matrix(style_img_second))

plt.subplot(2, 2, 3)
plt.title('content')
plt.imshow(tensor_to_matrix(content_img))

plt.subplot(2, 2, 4)
plt.title('outout')
plt.imshow(tensor_to_matrix(output))


plt.ioff()
plt.show()
```

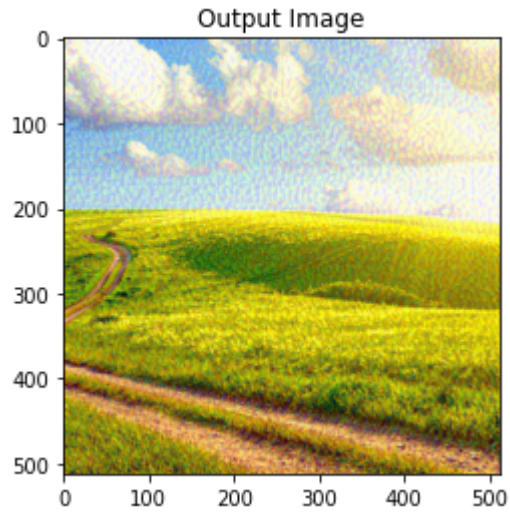

```
input_img = content_img.clone()
# if you want to use white noise instead uncomment the below line:
#input_img = torch.randn(content_img.data.size(), device=device)

# add the original input image to the figure:
plt.figure()
imshow(input_img, title='Input Image')
output = run_style_transfer(cnn, cnn_normalization_mean, cnn_normalization_std,
                            content_img, style_img, style_img_second, input_img, alpha_

plt.figure()
imshow(output, title='Output Image')
#plt.imsave(output, 'output.png')
# sphinx_gallery_thumbnail_number = 4
plt.ioff()
plt.show()
```



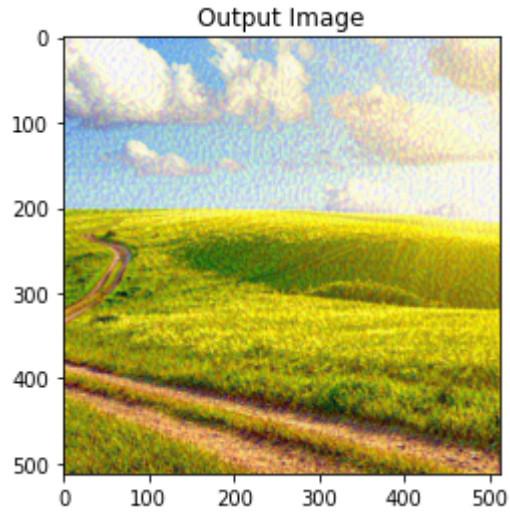

```
run [300]:
Style Loss : 409.905457 Style-Second Loss : 1190.224976 Content Loss: 23.982220
```




```
run [350]:
Style Loss : 389.535156 Style-Second Loss : 1192.620972 Content Loss: 24.453384
```

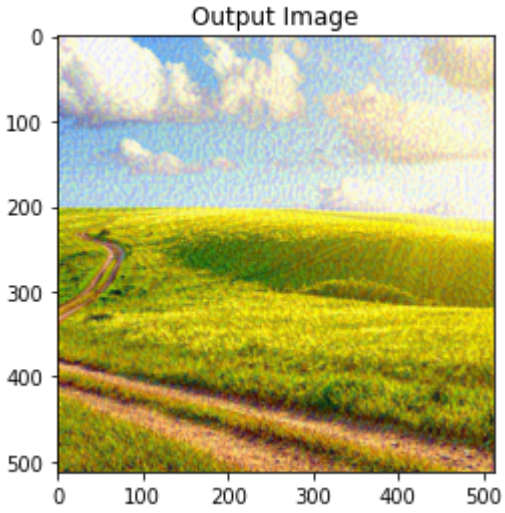



```
run [400]:
Style Loss : 374.901550 Style-Second Loss : 1193.886963 Content Loss: 24.804613
```

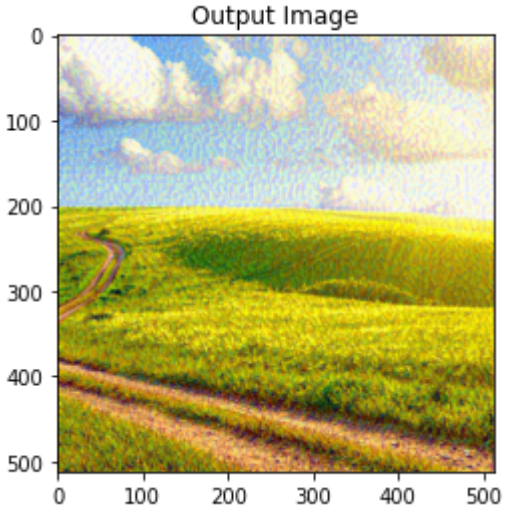


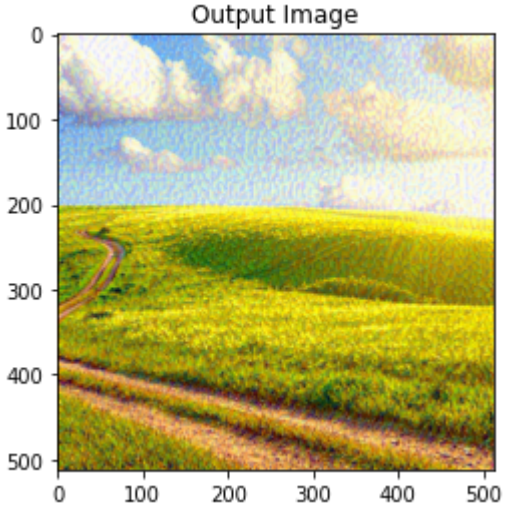

```
run [450]:
```

```
run [490]:
Style Loss : 364.102570 Style-Second Loss : 1194.523560 Content Loss: 25.067974
```



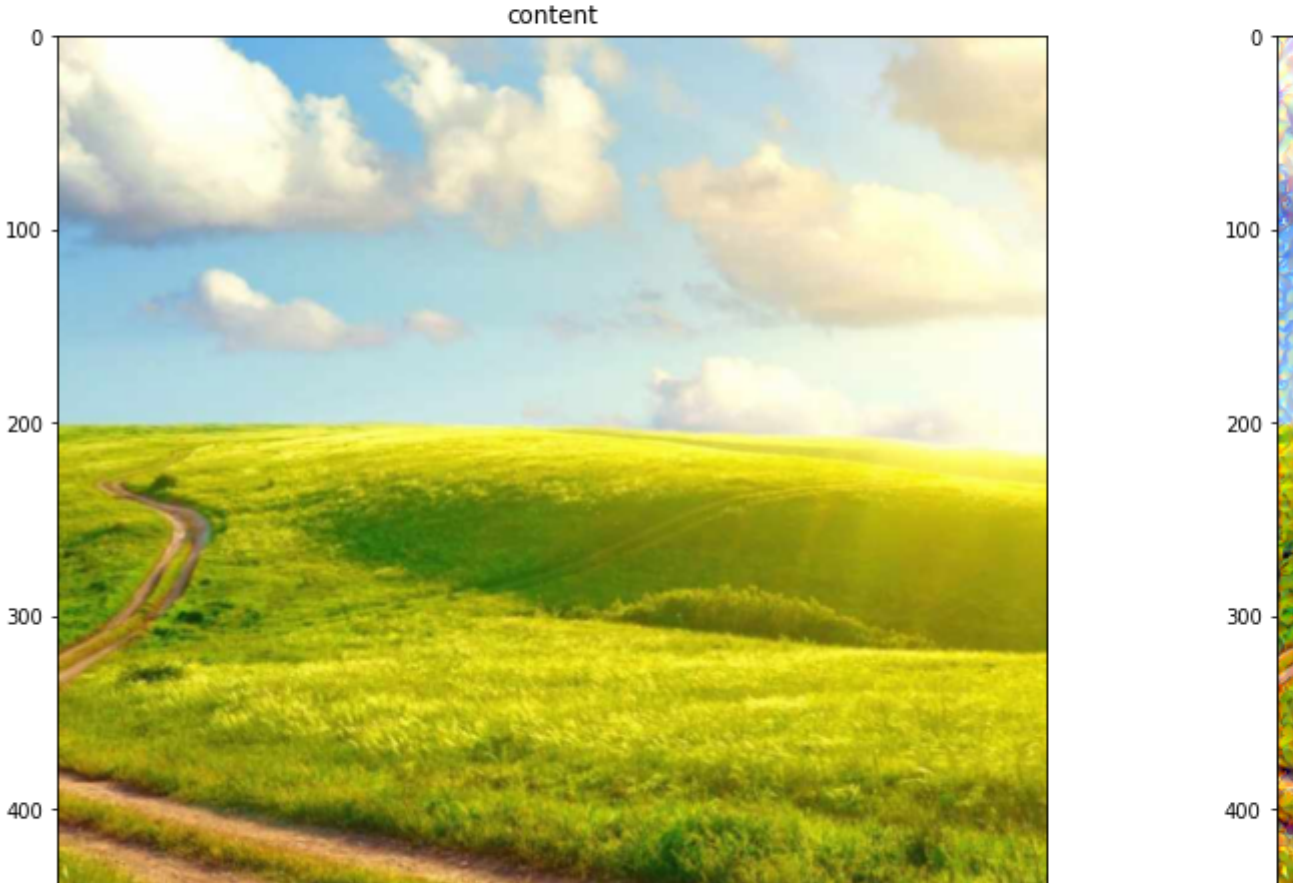

```
run [500]:
Style Loss : 356.037628 Style-Second Loss : 1194.721802 Content Loss: 25.264849
```



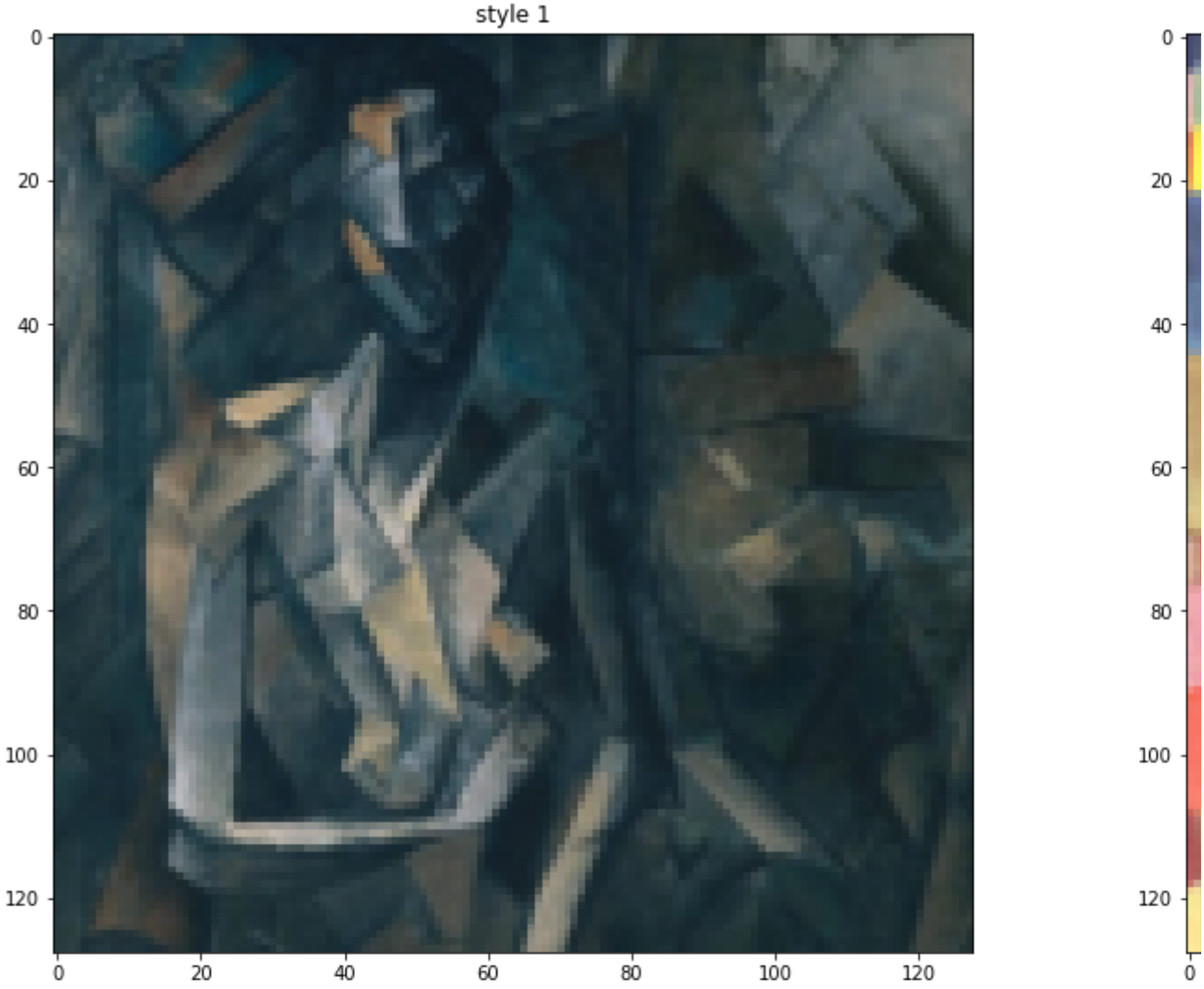


```
fig = plt.figure(figsize=(20,20), )

plt.subplot(2, 2, 1)
plt.title('style 1')
plt.imshow(tensor_to_matrix(style_img))

plt.subplot(2, 2, 2)
plt.title('style second')
plt.imshow(tensor_to_matrix(style_img_second))

plt.subplot(2, 2, 3)
plt.title('content')
plt.imshow(tensor_to_matrix(content_img))

plt.subplot(2, 2, 4)
plt.title('outout')
plt.imshow(tensor_to_matrix(output))


plt.ioff()
plt.show()
```

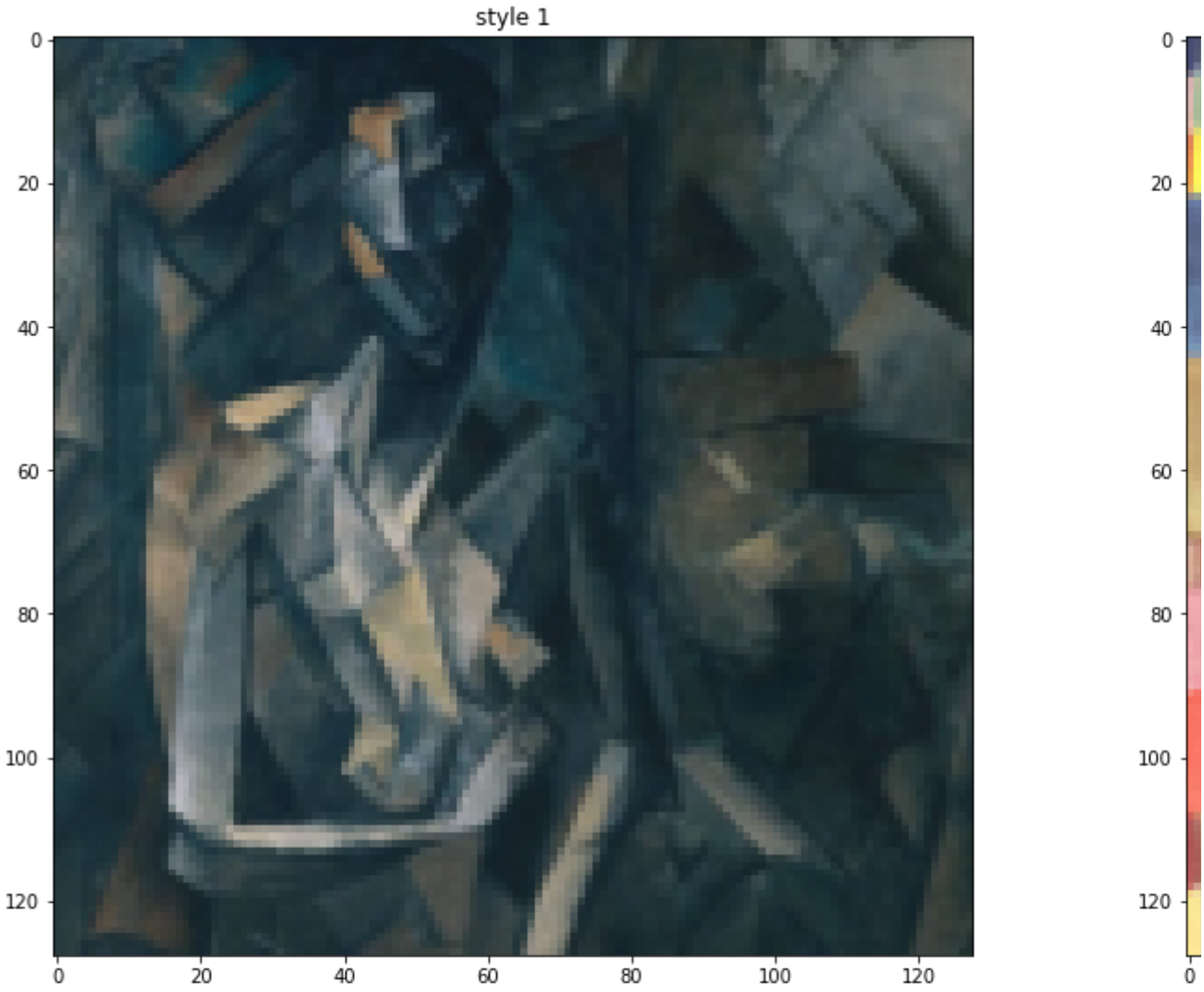

style 1
0
100
200
300
400
500

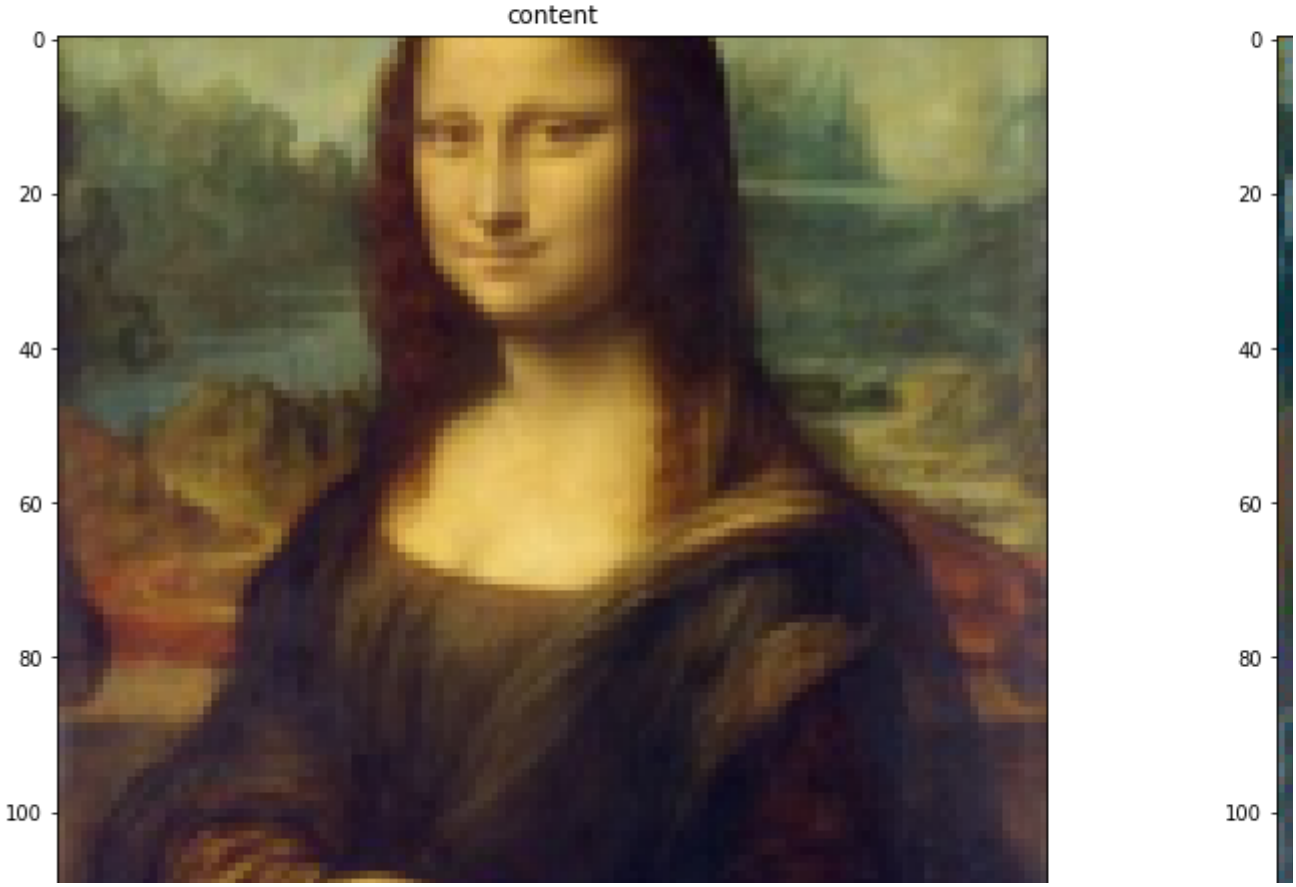

content
0
100
200
300
400

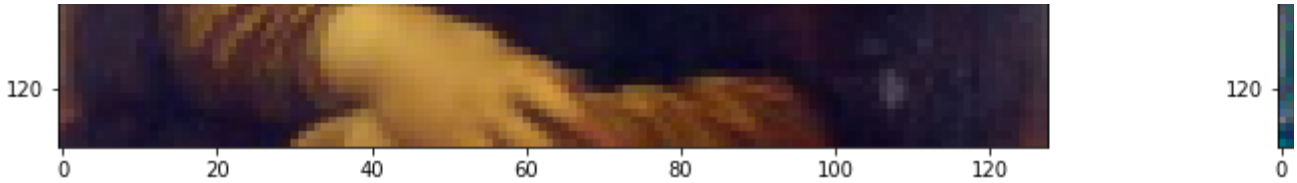
```
fig = plt.figure(figsize=(20,20), )

plt.subplot(2, 2, 1)
plt.title('style 1')
plt.imshow(tensor_to_matrix(style_img))

plt.subplot(2, 2, 2)
plt.title('style second')
plt.imshow(tensor_to_matrix(style_img_second))

plt.subplot(2, 2, 3)
plt.title('content')
plt.imshow(tensor_to_matrix(content_img))

plt.subplot(2, 2, 4)
plt.title('outout')
plt.imshow(tensor_to_matrix(output))


plt.ioff()
plt.show()
```




```
fig = plt.figure(figsize=(20,20), )

plt.subplot(2, 2, 1)
plt.title('style 1')
plt.imshow(tensor_to_matrix(style_img))

plt.subplot(2, 2, 2)
plt.title('style second')
plt.imshow(tensor_to_matrix(style_img_second))

plt.subplot(2, 2, 3)
plt.title('content')
plt.imshow(tensor_to_matrix(content_img))

plt.subplot(2, 2, 4)
plt.title('outout')
plt.imshow(tensor_to_matrix(output))


plt.ioff()
plt.show()
```


style 1
0
20
40
60
80
100
120


content
0
20
40
60
80
100




```
fig = plt.figure(figsize=(20,20), )

plt.subplot(2, 2, 1)
plt.title('style 1')
plt.imshow(tensor_to_matrix(style_img))

plt.subplot(2, 2, 2)
plt.title('style second')
plt.imshow(tensor_to_matrix(style_img_second))

plt.subplot(2, 2, 3)
plt.title('content')
plt.imshow(tensor_to_matrix(content_img))

plt.subplot(2, 2, 4)
plt.title('outout')
plt.imshow(tensor_to_matrix(output))


plt.ioff()
plt.show()
```


```
!wget https://art-holst.com.ua/wp-content/uploads/thumb_1_28551.jpg -O /content/images/
#content_img = image_loader("images/picasso.jpg")# as well as here
#style_img = image_loader("images/lisa.jpg")#измените путь на тот который у вас.
style_img = image_loader("images/first_style.jpg")# as well as here
style_img_second = image_loader("images/second_style.jpg")# as well as here
content_img = image_loader("images/content.jpg")#измените путь на тот который у вас.
```

```
--2020-06-08 12:47:48--  https://art-holst.com.ua/wp-content/uploads/thumb_1_28551.jp
Resolving art-holst.com.ua (art-holst.com.ua)... 104.26.2.77, 104.26.3.77, 172.67.73.
Connecting to art-holst.com.ua (art-holst.com.ua)|104.26.2.77|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 132670 (130K) [image/jpeg]
Saving to: ‘/content/images/second_style.jpg’

/content/images/sec 100%[===================>] 129.56K  --.-KB/s    in 0.01s

2020-06-08 12:47:48 (9.22 MB/s) - ‘/content/images/second_style.jpg’ saved [132670/13
```

```
input_img = content_img.clone()
# if you want to use white noise instead uncomment the below line:
#input_img = torch.randn(content_img.data.size(), device=device)
```