Style

November 29, 2019

1 Style Transfer

[0]:
```
# import resources
%matplotlib inline

from PIL import Image
from io import BytesIO
import matplotlib.pyplot as plt
import numpy as np

import torch
import torch.optim as optim
import requests
from torchvision import transforms, models
```

2 VGG19

[0]:
```
vgg = models.vgg19(pretrained=True).features

for param in vgg.parameters():
    param.requires_grad_(False)
```

[38]:
```
device = torch.device("cuda" if torch.cuda.is_available() else "cpu")

vgg.to(device)
print(vgg)
```

```
Sequential(
  (0): Conv2d(3, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
  (1): ReLU(inplace=True)
  (2): Conv2d(64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
  (3): ReLU(inplace=True)
  (4): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1,
ceil_mode=False)
  (5): Conv2d(64, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
```

```
  (6): ReLU(inplace=True)
  (7): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
  (8): ReLU(inplace=True)
  (9): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1,
ceil_mode=False)
  (10): Conv2d(128, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
  (11): ReLU(inplace=True)
  (12): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
  (13): ReLU(inplace=True)
  (14): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
  (15): ReLU(inplace=True)
  (16): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
  (17): ReLU(inplace=True)
  (18): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1,
ceil_mode=False)
  (19): Conv2d(256, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
  (20): ReLU(inplace=True)
  (21): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
  (22): ReLU(inplace=True)
  (23): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
  (24): ReLU(inplace=True)
  (25): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
  (26): ReLU(inplace=True)
  (27): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1,
ceil_mode=False)
  (28): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
  (29): ReLU(inplace=True)
  (30): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
  (31): ReLU(inplace=True)
  (32): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
  (33): ReLU(inplace=True)
  (34): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
  (35): ReLU(inplace=True)
  (36): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1,
ceil_mode=False)
)
```

3 Load Images

[0]:
```python
def load_image(img_path, max_size=400, shape=None):
    if "http" in img_path:
        response = requests.get(img_path)
        image = Image.open(BytesIO(response.content)).convert('RGB')
    else:
        image = Image.open(img_path).convert('RGB')
```

```
    # large images will slow down processing
    if max(image.size) > max_size:
        size = max_size
    else:
        size = max(image.size)

    if shape is not None:
        size = shape

    in_transform = transforms.Compose([
                        transforms.Resize(size),
                        transforms.ToTensor(),
                        transforms.Normalize((0.485, 0.456, 0.406),
                                             (0.229, 0.224, 0.225))])

    # discard the transparent, alpha channel and add batch
    image = in_transform(image)[:3,:,:].unsqueeze(0)

    return image
```

[0]:
```
def im_convert(tensor):
    image = tensor.to("cpu").clone().detach()
    image = image.numpy().squeeze()
    image = image.transpose(1,2,0)
    image = image * np.array((0.229, 0.224, 0.225)) + np.array((0.485, 0.456, 0.
↪406))
    image = image.clip(0, 1)

    return image
```

[0]:
```
content = load_image('octopus.jpg').to(device)

style = load_image('Dark.png', shape=content.shape[-2:]).to(device)
```

[42]:
```
fig, (ax1, ax2) = plt.subplots(1, 2, figsize=(20, 10))

ax1.imshow(im_convert(content))
ax2.imshow(im_convert(style))
```

[42]:
```
<matplotlib.image.AxesImage at 0x7f456e20d4a8>
```

4 Content and Style Features

[0]:
```
def get_features(image, model, layers=None) -> dict:
    """ Run an image forward through a model and get the features for a set of␣
 ↪layers. """
    if layers is None:
        layers = {'0': 'conv1_1',
                  '5': 'conv2_1',
                  '10': 'conv3_1',
                  '19': 'conv4_1',
                  '21': 'conv4_2',  ## content representation
                  '28': 'conv5_1'}

    features = {}
    x = image

    for name, layer in model._modules.items():
        x = layer(x)
        if name in layers:
            features[layers[name]] = x

    return features
```

5 Gram Matrix

[0]:
```
def gram_matrix(tensor) -> torch.Tensor:
    """ Calculate the Gram Matrix of a given tensor
        Gram Matrix from :v https://en.wikipedia.org/wiki/Gramian_matrix
    """

    _, d, h, w = tensor.size()
```

```
    # reshape so we're multiplying the features for each channel
    tensor = tensor.view(d, h * w)

    gram = torch.mm(tensor, tensor.t())

    return gram
```

[0]:
```
content_features = get_features(content, vgg)
style_features = get_features(style, vgg)

# calculate the gram matrices for each layer of our style representation
style_grams = {layer: gram_matrix(style_features[layer]) for layer in␣
 ↪style_features}

# create a target image and prep it for change
target = content.clone().requires_grad_(True).to(device)
```

6 Loss

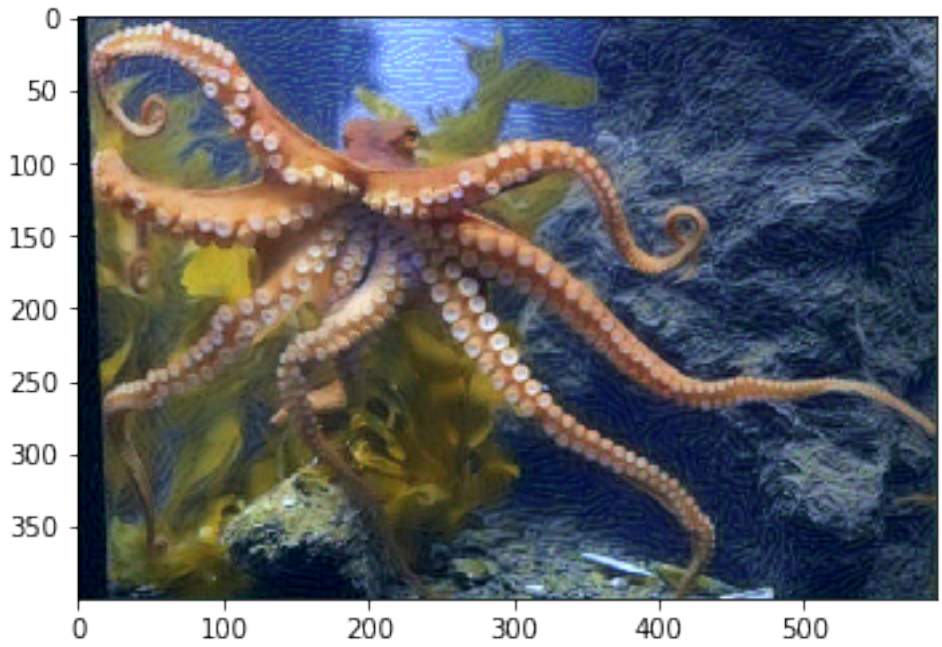
[0]:
```
style_weights = {'conv1_1': 1.,
                 'conv2_1': 0.75,
                 'conv3_1': 0.2,
                 'conv4_1': 0.2,
                 'conv5_1': 0.2}

content_weight = 1  # alpha
style_weight = 1e6  # beta
```

7 Train loop (from Udacity course)

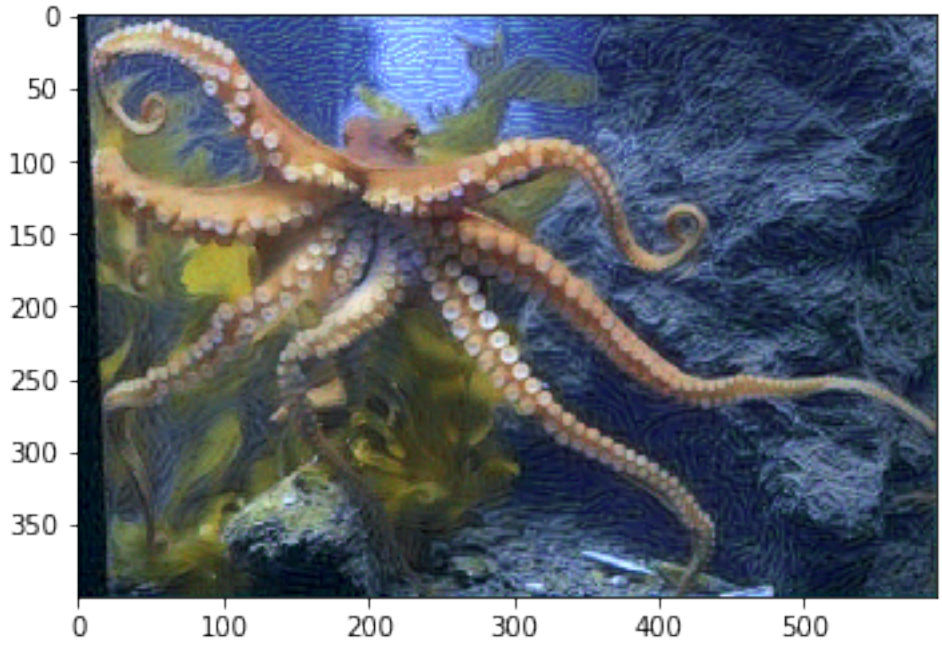
[47]:
```
show_every = 350

optimizer = optim.Adam([target], lr=0.003)
steps = 2000

for ii in range(1, steps+1):
    target_features = get_features(target, vgg)
    content_loss = torch.mean((target_features['conv4_2'] -␣
 ↪content_features['conv4_2'])**2)

    # the style loss
    style_loss = 0

    if ii % 50 == 0: print(f"{ii / steps * 100}%")
```

```
    for layer in style_weights:
        # get the "target" style representation for the layer
        target_feature = target_features[layer]
        target_gram = gram_matrix(target_feature)
        _, d, h, w = target_feature.shape

        style_gram = style_grams[layer]
        layer_style_loss = style_weights[layer] * torch.mean((target_gram -␣
↪style_gram)**2)

        style_loss += layer_style_loss / (d * h * w)

    total_loss = content_weight * content_loss + style_weight * style_loss

    # update target
    optimizer.zero_grad()
    total_loss.backward()
    optimizer.step()

    # display intermediate images and print the loss
    if  ii % show_every == 0:
        print('Total loss: ', total_loss.item())
        plt.imshow(im_convert(target))
        plt.show()
```

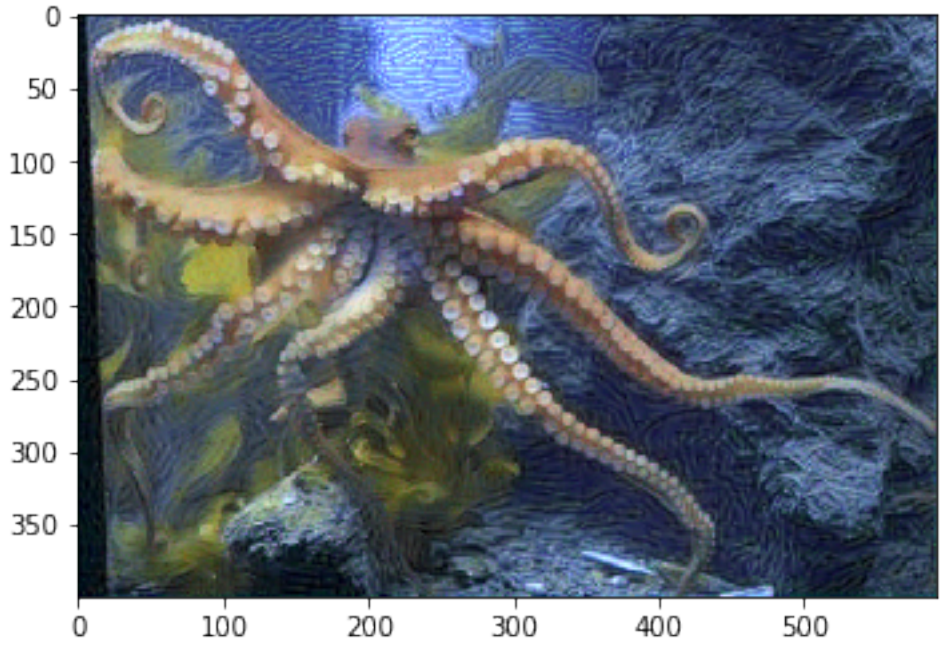
```
2.5%
5.0%
7.5%
10.0%
12.5%
15.0%
17.5%
Total loss:  6446763.5
```



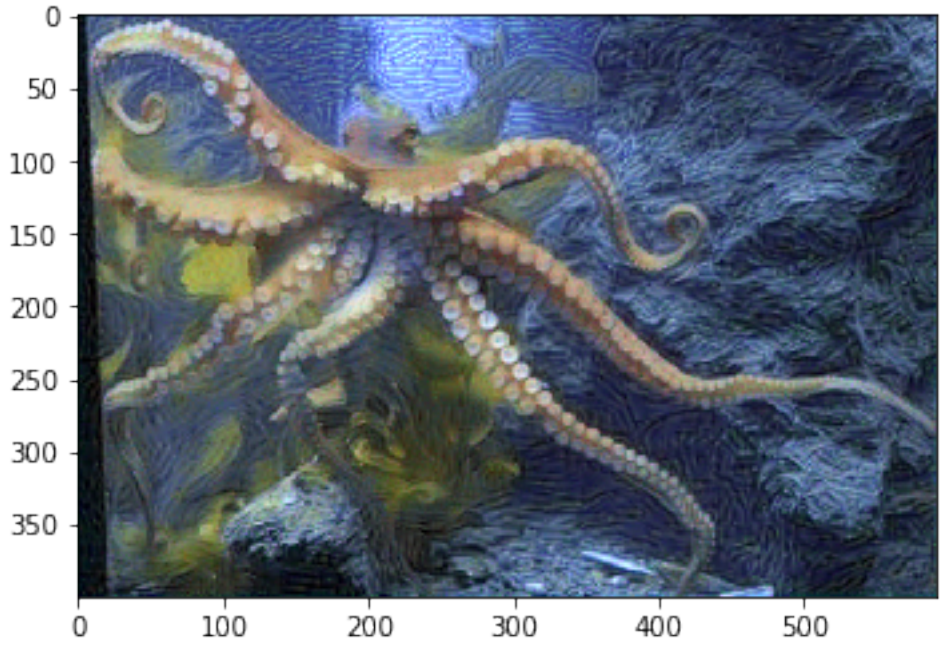

```
20.0%
22.5%
25.0%
27.500000000000004%
30.0%
32.5%
35.0%
Total loss:  1900207.0
```



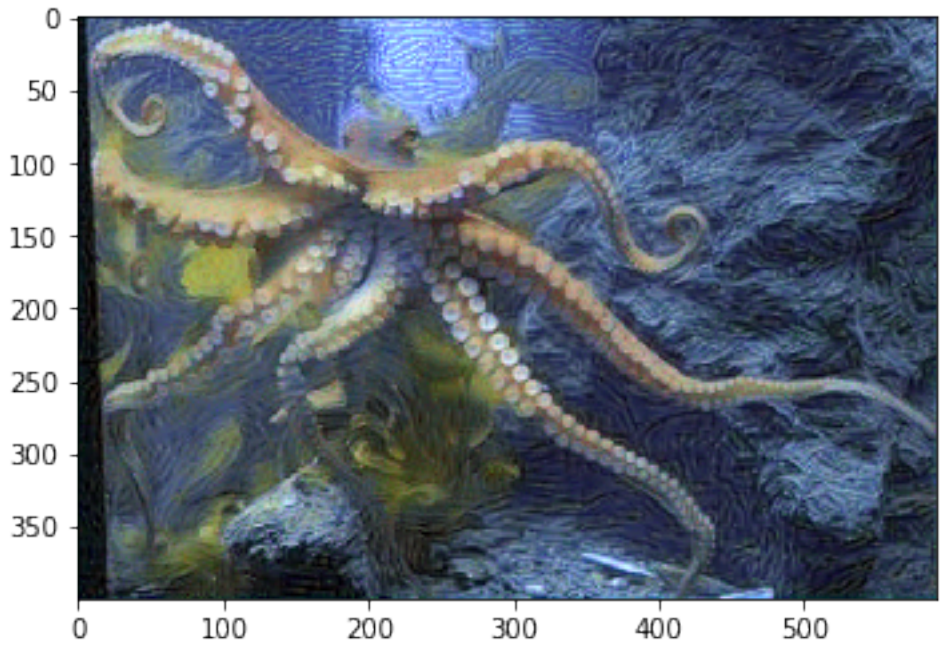

```
37.5%
40.0%
42.5%
45.0%
47.5%
50.0%
52.5%
Total loss:  778403.9375
```




```
55.00000000000001%
57.49999999999999%
60.0%
62.5%
65.0%
67.5%
70.0%
Total loss:  409117.40625
```




```
72.5%
75.0%
77.5%
80.0%
82.5%
85.0%
87.5%
Total loss:  256645.5
```




```
90.0%
92.5%
95.0%
97.5%
100.0%
```

[52]:
```
fig, ax1 = plt.subplots(1, 1, figsize=(20, 10))
ax1.imshow(im_convert(style))
```

[52]:
```
<matplotlib.image.AxesImage at 0x7f456e2f31d0>
```

[48]:
```
fig, (ax1, ax2) = plt.subplots(1, 2, figsize=(20, 10))
ax1.imshow(im_convert(content))
ax2.imshow(im_convert(target))
```

[48]:
```
<matplotlib.image.AxesImage at 0x7f4566524550>
```