This is from:
https://github.com/FarisNolan/Neural_Algorithm_Artistic_Style/blob/master/N_A_A_S.py
(https://github.com/FarisNolan/Neural_Algorithm_Artistic_Style/blob/master/N_A_A_S.py)

In [ ]:
```
# -*- coding: utf-8 -*-
# """
# Created on Thu Dec 27 08:33:31 2018
# @author: Faris
# """

# Modified by Scott Mueller for use in a Jupyter Notebook
# Handles multiple content files and one Style


```

In [2]:
```
#-----IMPORTS AND DIRECTORIES-----
import time
import os
```

In [3]:
```
image_dir = 'images/'
model_dir = 'model/'
```

In [4]:
```
import torch
from torch.autograd import Variable
import torch.nn as nn
import torch.nn.functional as F
from torch import optim
```

In [5]:
```
import torchvision
from torchvision import transforms
```

In [6]:
```
from PIL import Image
from collections import OrderedDict
```

In [7]:
```
import matplotlib.pyplot as plt
```

In [ ]:
```

```

In [8]:

```
#CAN RETURN OUTPUT FROM ANY LAYER
class VGG(nn.Module):
    def __init__(self, pool='max'):
        super(VGG, self).__init__()
        #CONV LAYERS
        self.conv1_1 = nn.Conv2d(3, 64, kernel_size = 3, padding = 1)
        self.conv1_2 = nn.Conv2d(64, 64, kernel_size = 3, padding = 1)

        self.conv2_1 = nn.Conv2d(64, 128, kernel_size = 3, padding = 1)
        self.conv2_2 = nn.Conv2d(128, 128, kernel_size = 3, padding = 1)

        self.conv3_1 = nn.Conv2d(128, 256, kernel_size = 3, padding = 1)
        self.conv3_2 = nn.Conv2d(256, 256, kernel_size = 3, padding = 1)
        self.conv3_3 = nn.Conv2d(256, 256, kernel_size = 3, padding = 1)
        self.conv3_4 = nn.Conv2d(256, 256, kernel_size = 3, padding = 1)

        self.conv4_1 = nn.Conv2d(256, 512, kernel_size = 3, padding = 1)
        self.conv4_2 = nn.Conv2d(512, 512, kernel_size = 3, padding = 1)
        self.conv4_3 = nn.Conv2d(512, 512, kernel_size = 3, padding = 1)
        self.conv4_4 = nn.Conv2d(512, 512, kernel_size = 3, padding = 1)

        self.conv5_1 = nn.Conv2d(512, 512, kernel_size = 3, padding = 1)
        self.conv5_2 = nn.Conv2d(512, 512, kernel_size = 3, padding = 1)
        self.conv5_3 = nn.Conv2d(512, 512, kernel_size = 3, padding = 1)
        self.conv5_4 = nn.Conv2d(512, 512, kernel_size = 3, padding = 1)

        #HANDLE POOLING OPTIONS
        #MAX POOLING
        if pool == 'max':
            self.pool1 = nn.MaxPool2d(kernel_size = 2, stride = 2)
            self.pool2 = nn.MaxPool2d(kernel_size = 2, stride = 2)
            self.pool3 = nn.MaxPool2d(kernel_size = 2, stride = 2)
            self.pool4 = nn.MaxPool2d(kernel_size = 2, stride = 2)
            self.pool5 = nn.MaxPool2d(kernel_size = 2, stride = 2)
        #AVERAGE POOLING
        elif pool == 'avg':
            self.pool1 = nn.AvgPool2d(kernel_size = 2, stride = 2)
            self.pool2 = nn.AvgPool2d(kernel_size = 2, stride = 2)
            self.pool3 = nn.AvgPool2d(kernel_size = 2, stride = 2)
            self.pool4 = nn.AvgPool2d(kernel_size = 2, stride = 2)
            self.pool5 = nn.AvgPool2d(kernel_size = 2, stride = 2)

        #FORWARD PROP
    def forward(self, x, out_keys):
        out = {}

        out['r11'] = F.relu(self.conv1_1(x))
        out['r12'] = F.relu(self.conv1_2(out['r11']))
        out['p1'] = self.pool1(out['r12'])

        out['r21'] = F.relu(self.conv2_1(out['p1']))
        out['r22'] = F.relu(self.conv2_2(out['r21']))
        out['p2'] = self.pool2(out['r22'])

        out['r31'] = F.relu(self.conv3_1(out['p2']))
        out['r32'] = F.relu(self.conv3_2(out['r31']))
```

```
        out['r33'] = F.relu(self.conv3_3(out['r32']))
        out['r34'] = F.relu(self.conv3_4(out['r33']))
        out['p3'] = self.pool3(out['r34'])

        out['r41'] = F.relu(self.conv4_1(out['p3']))
        out['r42'] = F.relu(self.conv4_2(out['r41']))
        out['r43'] = F.relu(self.conv4_3(out['r42']))
        out['r44'] = F.relu(self.conv4_4(out['r43']))
        out['p4'] = self.pool4(out['r44'])

        out['r51'] = F.relu(self.conv5_1(out['p4']))
        out['r52'] = F.relu(self.conv5_2(out['r51']))
        out['r53'] = F.relu(self.conv5_3(out['r52']))
        out['r54'] = F.relu(self.conv5_4(out['r53']))
        out['p5'] = self.pool5(out['r54'])


        #RETURN DESIRED ACTIVATIONs
        return [out[key] for key in out_keys]

```

In [9]:

```
#------------------------------------------------------
#-----COMPUTING GRAM MATRIX AND GRAM MATRIX LOSS-----.0
#------------------------------------------------------

#GRAM MATRICES ARE USED TO MEASURE STYLE LOSS
#MATRIX
class GramMatrix(nn.Module):
    def forward(self, input):
        b, c, w, h = input.size()
        F = input.view(b, c, h * w)
        #COMPUTES GRAM MATRIX BY MULTIPLYING INPUT BY TRANPOSE OF ITSELF
        G = torch.bmm(F, F.transpose(1, 2))
        G.div_(h*w)
        return G

#LOSS
class GramMSELoss(nn.Module):
    def forward(self, input, target):
        out = nn.MSELoss()(GramMatrix()(input), target)
        return out

```

In [32]:

```
img_size = 256

#PRE-PROCESSING
prep = transforms.Compose([transforms.Scale(img_size),
                           transforms.ToTensor(),
                           transforms.Lambda(lambda x: x[torch.LongTensor([2
                           transforms.Normalize(mean = [0.40760392, 0.457956
                           transforms.Lambda(lambda x: x.mul_(255)), #VGG WA
])
```

In [33]:
```
#POST PROCESSING A
postpa = transforms.Compose([transforms.Lambda(lambda x: x.mul_(1./255)),
                             transforms.Normalize(mean = [-0.40760392, -0.457
                             transforms.Lambda(lambda x: x[torch.LongTensor([
        ])
```

In [34]:
```
#POST PROCESSING B
postpb = transforms.Compose([transforms.ToPILImage()])

#POST PROCESSING FUNCTION INCORPORATES A AND B, AND CLIPS PIXEL VALUES WHICH
def postp(tensor):
    t = postpa(tensor)
    t[t>1] = 1
    t[t<0] = 0
    img = postpb(t)
    return img

```

In [35]:
```
#---------------------------
#-----PREPARING NETWORK-----
#---------------------------

vgg = VGG()

vgg.load_state_dict(torch.load(model_dir + 'vgg_conv_weights.pth'))
for param in vgg.parameters():
    param.requires_grad = False
if torch.cuda.is_available():
    vgg.cuda()
```

In [97]:
```
#-----LOADING AND PREPARING IMAGES-----
img_dirs = [image_dir, image_dir]

#IMAGE LOADING ORDER: STYLE, CONTENT
# img_names = ['style_vandrie_yellow_forest.jpg', 'content_rocky_lake.jpg']
# img_names = ['style_monet_sunset.jpg', 'content_tree.jpg' ]
# img_names = ['style_monet_sunset.jpg', 'content_evening_city.jpg' ]
img_names = ['style_group7_moutains.jpg', 'content_evening_city.jpg' ]

imgs = [Image.open(img_dirs[i] + name) for i, name in enumerate(img_names)]
imgs_torch = [prep(img) for img in imgs]
```

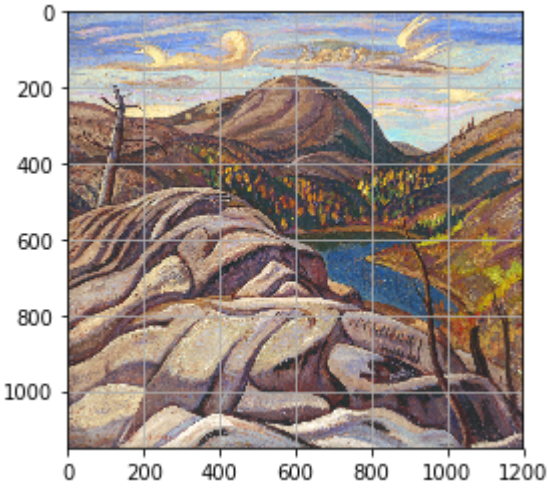
In [98]:

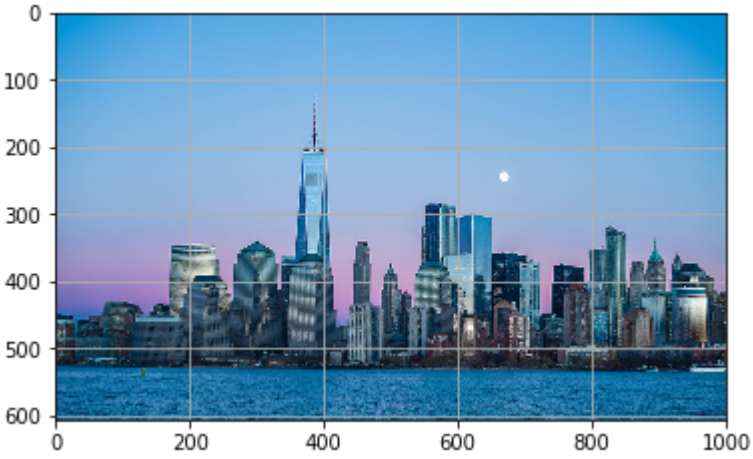
```
#HANDLE CUDA
if torch.cuda.is_available():
    imgs_torch = [Variable(img.unsqueeze(0)).cuda() for img in imgs_torch]
else:
    imgs_torch = [Variable(img.unsqueeze(0)) for img in imgs_torch]
style_img, content_img = imgs_torch
for img in imgs_torch:
  print("Image size: ", img.size())
```

```
Image size:  torch.Size([1, 3, 256, 267])
Image size:  torch.Size([1, 3, 256, 421])
```

In [99]:
```
#SET UP IMAGE TO BE OPTIMIZED
#CAN BE INITIALIZED RANDOMLY OR AS A CLONE OF CONTENT IMAGE, AS DONE BELOW
opt_img = Variable(content_img.clone(), requires_grad = True)
print(content_img.size())
print(opt_img.size())

#DISPLAY IMAGES
for img in imgs:
    plt.grid(None)
    plt.imshow(img)
    plt.show()
```

```
torch.Size([1, 3, 256, 421])
torch.Size([1, 3, 256, 421])
```





In [100]:
```
#----------------------------
#-----SETUP FOR TRAINING-----
#----------------------------
#LAYERS FOR STYLE AND CONTENT LOSS
style_layers = ['r11', 'r12', 'r31', 'r41', 'r51']
content_layers = ['r42']
loss_layers = style_layers + content_layers

```

In [101]:
```
#CREATING LOSS FUNCTION
loss_fns = [GramMSELoss()] * len(style_layers) + [nn.MSELoss()] * len(conten
if torch.cuda.is_available():
    loss_fns = [loss_fn.cuda() for loss_fn in loss_fns]
```

In [102]:
```
#SETUP WEIGHTS FOR LOSS LAYERS
style_weights = [1e3/n**2 for n in [64, 128, 256, 512, 512]]
content_weights = [1e0]
weights = style_weights + content_weights
```

In [103]:
```
#CREATE OPTIMIZATION TARGETS
style_targets = [GramMatrix()(A).detach() for A in vgg(style_img, style_laye
content_targets = [A.detach() for A in vgg(content_img, content_layers)]
targets = style_targets + content_targets

```

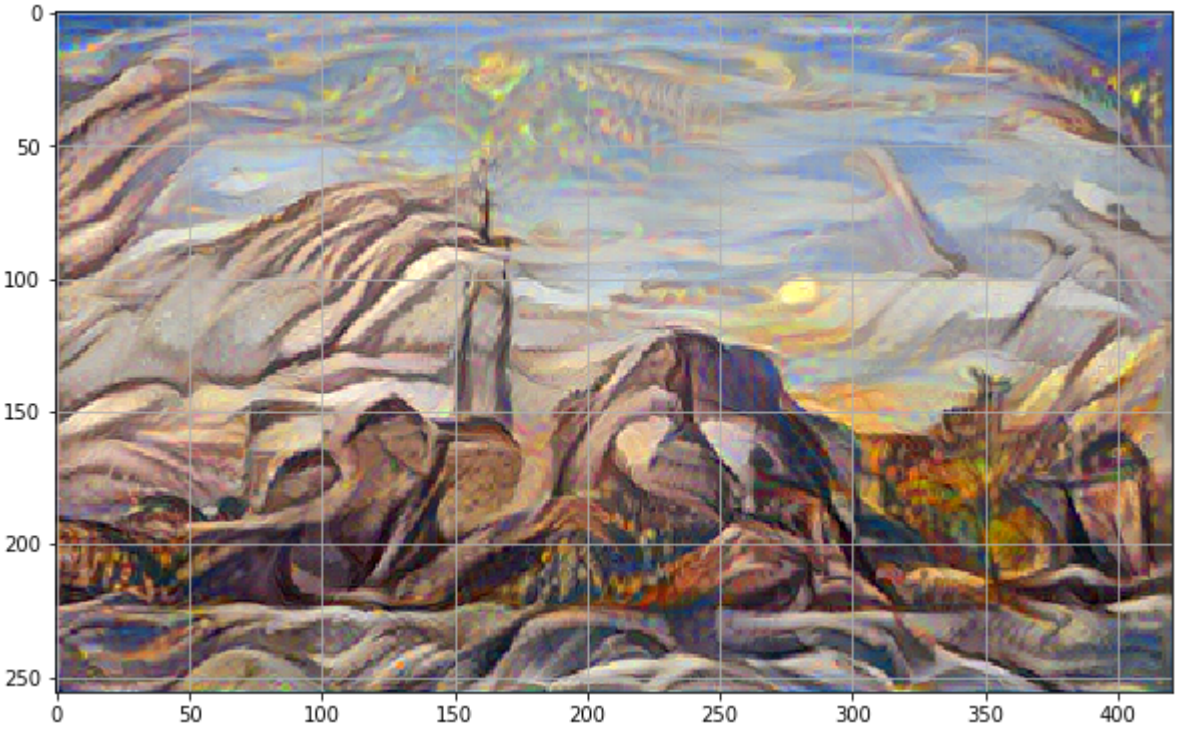
In [104]:

```
#----------------------
#-----TRAINING LOOP-----
#----------------------
max_iter = 500
show_iter = 50
optimizer = optim.LBFGS([opt_img])
print(opt_img.size())
print(content_img.size())
n_iter = [0]

#ENTER LOOP
while n_iter[0] <= max_iter:

    def closure():
        optimizer.zero_grad()

        #FORWARD
        out = vgg(opt_img, loss_layers)

        #LOSS
        layer_losses = [weights[a] * loss_fns[a](A, targets[a]) for a,A in e
        loss = sum(layer_losses)

        #BACKWARDS
        loss.backward()

        #TRACK PROGRESS
        n_iter[0] += 1
        if n_iter[0] % show_iter == (show_iter - 1):
            print('Iteration: %d,\tLoss: %f' % (n_iter[0] + 1, loss.data.ite

        return loss

    optimizer.step(closure)
```

```
torch.Size([1, 3, 256, 421])
torch.Size([1, 3, 256, 421])
Iteration: 50,  Loss: 2307373.750000
Iteration: 100, Loss: 1107767.000000
Iteration: 150, Loss: 853558.125000
Iteration: 200, Loss: 749934.500000
Iteration: 250, Loss: 695015.687500
Iteration: 300, Loss: 658969.437500
Iteration: 350, Loss: 634196.312500
Iteration: 400, Loss: 615544.687500
Iteration: 450, Loss: 601844.125000
Iteration: 500, Loss: 590653.500000
```

In [105]:
```
#-----------------
#-----RESULTS-----
#-----------------
print(float(opt_img.size(3)))
print(float(content_img.size(3)))
out_img = postp(opt_img.data[0].cpu().squeeze())
print(float(prep(out_img).size(2)))
plt.grid(None)
plt.imshow(out_img)
plt.gcf().set_size_inches(10, 10)
```

```
421.0
421.0
421.0
```



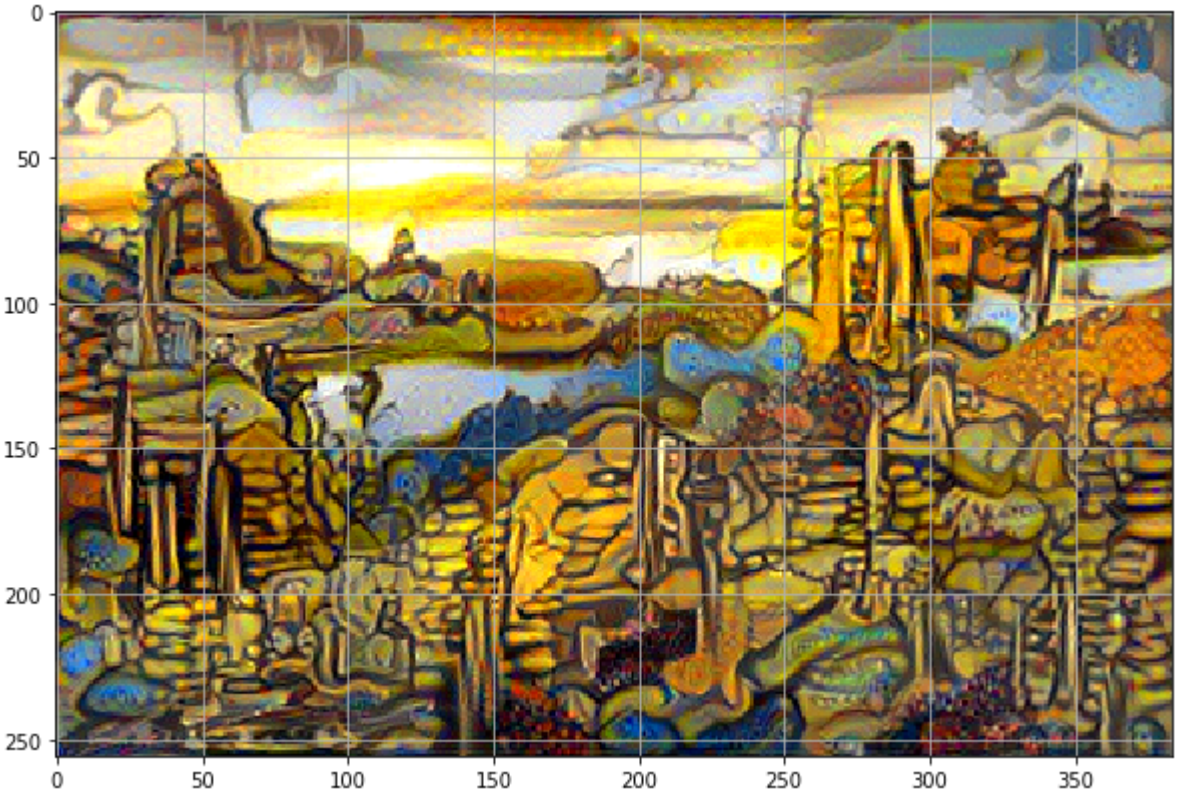
In [108]:
```
out_img.save('city_group7_mountain_style.png')
```

In [58]:
```
#-----------------
#-----RESULTS-----
#-----------------
print(float(opt_img.size(3)))
print(float(content_img.size(3)))
out_img = postp(opt_img.data[0].cpu().squeeze())
print(float(prep(out_img).size(2)))
plt.grid(None)
plt.imshow(out_img)
plt.gcf().set_size_inches(10, 10)
```

```
421.0
421.0
421.0
```

In [46]:
```
#-----------------
#-----RESULTS-----
#-----------------
print(float(opt_img.size(3)))
print(float(content_img.size(3)))
out_img = postp(opt_img.data[0].cpu().squeeze())
print(float(prep(out_img).size(2)))
plt.grid(None)
plt.imshow(out_img)
plt.gcf().set_size_inches(10, 10)
```

```
256.0
384.0
384.0
```



In [ ]:
```
1
```

In [ ]:
```
1
```