# IMAGE STYLE TRANSFER WITH NEURAL NETWORK

*Nikitin G.Y.*

*Belarusian State University of Informatics and Radioelectronics, Minsk, Belarus*

In this article we present the way to transfer style from one image to the content of another with convolutional neural networks and extra transformations.

In fine art, especially painting, humans have mastered the skill to create unique visual experiences through composing a complex interplay between the content and style of an image. Thus far the algorithmic basis of this process is unknown and there exists no artificial system with similar capabilities.

However, in other key areas of visual perception such as object and face recognition near-human performance were recently demonstrated by a class of biologically inspired vision models called Deep Neural Networks. In this article we present an overview of currently existing methods based on a Deep Neural Network that creates artistic images of high perceptual quality. The systems use neural representations to separate and recombine content and style of arbitrary images, providing a neural algorithm for the creation of artistic images.

We'll take a look onto two major works in this field of science: "A Neural Algorithm of Artistic Style" (Gatys at el.) [1] and "Perceptual Losses for Real-Time Style Transfer and Super-Resolution" (Johnson at el.) [2].

Both works are based on the same neural network: VGG-19 (or VGG-16), presented in "Very deep convolutional networks for large-scale image recognition" [3]. If you take a closer look to image representation in VGG's layers you'll see, that the higher the network level, the higher the image representation features.

This means that VGG has developed image recognition functions that convey information about the image, slightly depend of the color and texture of the pixels of a particular image, but strongly depend on the shape of objects in the image. This property of VGG network can be easily used to create "content" representation of the image.

But what about the "style" part? At [1] Gatys introduced the concept of a gram-matrix transformation. Generally speaking, this is the way to represent information stored in layers of VGG about some specific image in terms of style by manipulating with already existing content representations. In other words, we manipulate with content representation of image to convert it into style representation. Exact formula of this transformation is being presented in Formula 1.

$$G_{ij}^{l} = \sum_{k} F_{ik}^{l} F_{jk}^{l} \tag{1}$$

Formula 1 can be explained as follows: gram-matrix is a multiplication of matrix (or tensor) on transposed representation of itself. So, we purify content representation, mixing information, stored in it to get only style filling of image.

VGG-16 is being represented on picture 1. According to this scheme we'll use 3 types of images: content image, we want to stylize; style image, we want to take style from; and fake image, that'll be our working image and is a copy of content image on iteration 0. The last 3 fully-connected layers aren't used.

Content representation means original filling of specified layer as output of network. Style representation means applying gram-matrix transformation to specified layer and conveying the result as output of network.

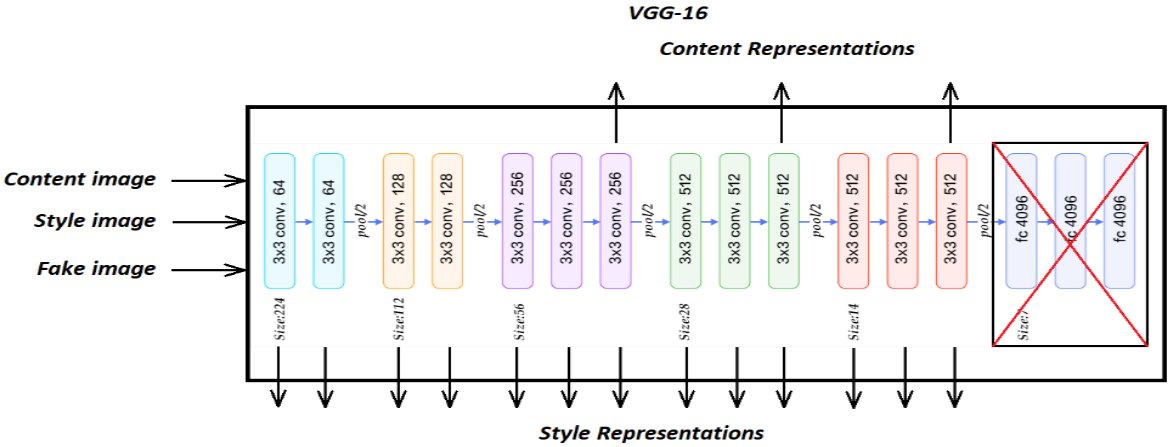
At the first step we have to calculate both content and style representations of fake image, content representation of original content image and style representation of style image. After these things done, we need to calculate losses (MSE, originally) between image representations and perform backward optimization of fake image. Note, that VGG will stay the same, as it was before, we will optimize only our fake image.

After some iterations fake image (content image, originally) will become more and more like style image with preservation of major content filling.

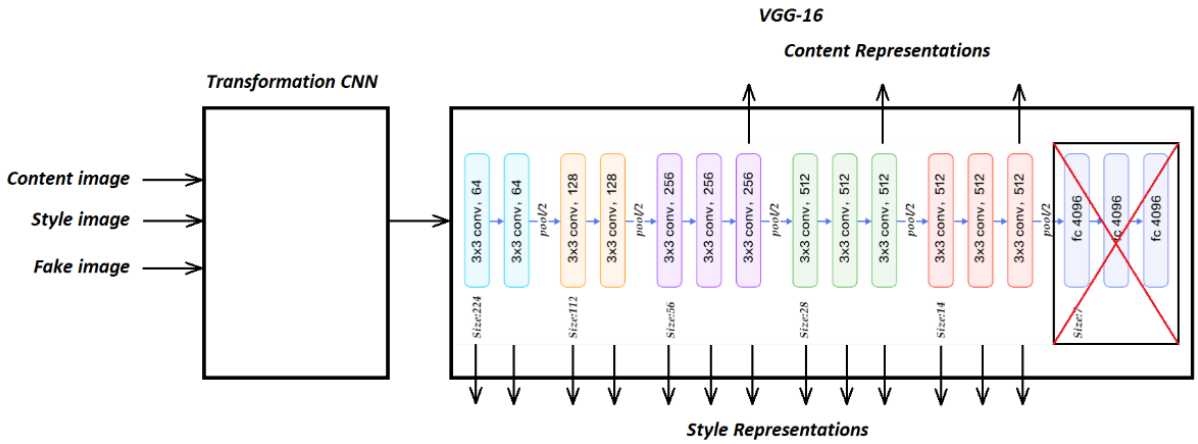
But optimization takes a lot of time and resources. Can't we make such system that'd make stylized image in seconds?

Actually, we can. In [2] Johnson offers us the way to train another neural network to apply chosen style to any image, given to it. Train process will take much more time and resources, rather than proposed by Gatys in [1], but after training you'll be able to create stylized images in second (or millisecond with suitable equipment) or apply stylization to video stream.

Main disadvantage of this method is that each neural network will apply only one chosen style of an image. Structure of the whole system presented in [2] is being shown in picture 2.




Picture 1. – Structure of VGG-16 network with content and style outputs.




Picture 2. – Structure of model by Johnson.

The only topic left uncovered is results. We've developed Python language model based on Gatys work. You can see an example on picture 3.

Picture 3. – Results (left to right content, style and result images).

***References:***

1. Image Style Transfer Using Convolutional Neural Networks [Electronic resource]. – Access mode : https://www.cv-foundation.org/openaccess/content_cvpr_2016/papers/Gatys_Image _Style_Transfer_CVPR_2016 _paper.pdf

2. Perceptual Losses for Real-Time Style Transfer and Super-Resolution [Electronic resource]. – Access mode : https://arxiv.org/pdf/1603.08155.pdf

3. Very deep convolutional networks for large-scale image recognition [Electronic resource]. – Access mode : https://arxiv.org/pdf/1409.1556.pdf

# THE FINANCIAL ANALYSIS OF THE MAIN FINANCIAL INDEXES AND ITS USE

*Kasmykova T.S.*

*Belarusian State University of Informatics and Radioelectronics, Minsk, Belarus*

The bankruptcy risk and the possibility of bankruptcy are of a major interest for banks,financial institutions, clients, etc. but also for investors and for the firms' managers. In the course of time, the diagnosis of bankruptcy had an impetuous development due to the use of statisticalmethods in the risk analysis.

If this organization is insolvent, it is important to examine the level of insolvency ( in other words, to check if it is temporary or permanent insolvency). It is necessary for making the decision what to do with the organization (if it is possible to reorganizateit or it is better to liquidate this organization (to let it pass through the procedures of bankruptcy).

The simplest way of financial analyses of bankruptcy is to examine some important indexes.

This type of analysis allows to investigate the levels of insolvency and to divide enterprises to bankrupts, enterprises with difficult financial situation and solvent enterprises.

According to the bankruptcy legislation of our country, there are three main financial indexes:

The first is the index of current liquidity (K1). It shows the level of working assets of an organization for its business.

The second is the index of the provision of an organization with own working assets (K2) which are needed for its financial stability.

And the third one is the index of the provision of financial obligations with assets (K3). It shows the possibility of an organization to pay all its debts after its assets are sold.

All this indexes have their norms, which are different for different branches of economy. Only K3 has its permanent norm for all branches.

If the level of indexes K1 and K2 of an organization are higher than their norms and the level of index K3 is lower than its norm,that means the organization is solvent.

If the situation is the opposite, that means that the organization is insolvent.

In this case the level of insolvency can be defined. So, if K1 and K2 are lower than their norms during one financial period (financial quarter) that means that the organization has temporary insolvency. And it is possible to rescue its financial situation by taking some simple financial measures.

If K1 and K2 are lower than their norms during four financial periods (financial quarters), that means that the insolvency of the organization is going to be permanent. And more serious financial measures are to be taken (like reorganization).

If K1 and K2 are lower than their norms during one financial period (financial year) and K3 is higher than its norm that means that the organization has permanent insolvency and this organization is a bankrupt. Only the liquidation of this organization is possible in this case.

Nowlook at some examples. So, for thatlet us imagine that 6 organizations are working in the sphere of heavy industry. The norms of indexes for heavy industry in our country are the following: K1 has to be higher or equal to 1.30; K2 has to be higher or equal to 0.20 and K3 has to be lower or equal to 0.85.

Table 1 -- Example of insolvency levels of organizations

| organizations | indexes | financial periods | | | | | norms | the level of solvency (insolvency) |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | | |
| | | 01.01.18 | 01.04.18 | 01.07.18 | 01.10.18 | 01.01.19 | | |
| A | K1 | 1.32 | 1.34 | 1.36 | 1.40 | 1.36 | 1.30 | solvent |
| | K2 | 0.21 | 0.23 | 0.25 | 0.27 | 0.25 | 0.20 | |
| | K3 | 0.64 | 0.66 | 0.68 | 0.70 | 0.68 | 0.85 | |
| B | K1 | 1.26 | 1.24 | 1.20 | 1.01 | 0.20 | 1.30 | permanent insolvency |
| | K2 | 0.18 | 0.16 | 0.12 | 0.08 | -0.34 | 0.20 | |
| | K3 | 0.85 | 0.85 | 0.90 | 0.98 | 2.08 | 0.85 | |
| C | K1 | 1.30 | 1.24 | 1.20 | 1.01 | 0.60 | 1.30 | the insolvency |