



1 Introduction

We present a method by which one can integrate a person's face into an artistic portrait painting.

We drew upon existing techniques of face swapping and portrait-specific neural style transfer, and build on this previous work in several ways:

- While a number of applications have focused on face swapping in recent years, they have generally been applied to photograph images with a similar style.
- The few methodologies that have used neural style transfer combined with face-swapping have transferred the transferred the style of the artistic image to the headshot image, without putting the newly-styled headshot image into the artistic image.

We compare our results which are based on the work by Selim et al. to two implementations of the neural style transfer paper by Gatys et al.

2 Prerequisites

Pre-trained networks

- VGG-19 (ImageNet)
- OpenCV Haar-feature face detector
- Dlib landmark detector

Except for pre-trained networks our approach does not require training data

Images

- Artistic portraits
- Headshot photos



1) Leon A Gatys, Alexander S Ecker, and Matthias Bethge. Image style transfer using convolutional neural networks. CVPR, 2016.

4) Dib. Neural style transfer implementation, 2018. <https://colab.research.google.com/github/titu1994/Neural-Style-Transfer/blob/master/NeuralStyleTransfer.py#b>.

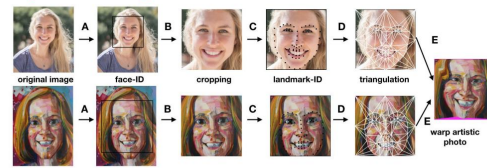
3 Methodology

Gatys loss $\mathcal{L}_{Total} = \sum_{l=1}^L \alpha_l \mathcal{L}_{style}^l + \sum_{l=1}^L \beta_l \mathcal{L}_{content}^l$
 Where: $\mathcal{L}_{content} = \frac{1}{2 N_l D_l} \sum_{ij} (F_l[A_G] - F_l[A_C])_{ij}^2$ and
 $\mathcal{L}_{style} = \frac{1}{2 N_l^2} \sum_{ij} (F_l[A_G] F_l[A_G]^T - F_l[A_S] F_l[A_S]^T)_{ij}^2$

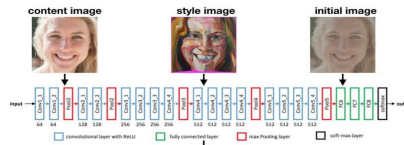
Selim adjustments to Gatys loss Replace $F[A_C]$ in \mathcal{L}_{style} with $F[A_M] = F[A_C] \times G_{Clamped}$ where G is a gain map that enables transfer of local color distributions and is calculated as:

$$G = F[A_S] / (F[A_C] + \epsilon) \quad \text{and} \\ G_{Clamped} = \max(\min(G, G_{max}), G_{min})$$

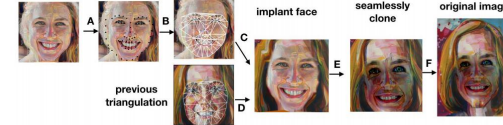
Pre-processing



Neural Style transfer



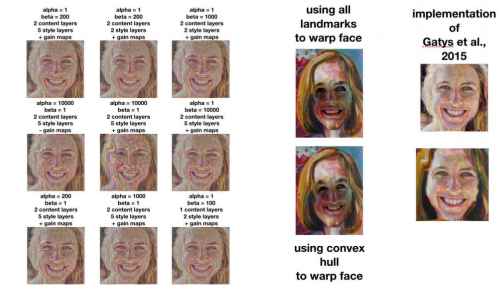
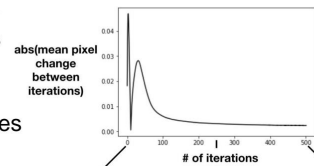
Face Swap



2) Ahmed Selim, Mohamed Elgharib, and Linda Doyle. Painting style transfer for head portraits using convolutional neural networks. (TOG), 2016.

4 Results: hyper-parameter sweep

Convergence at ~300 steps
 Parameter search show limited changes
 Best results obtained with open-source⁴ implementation of Gatys



5 Conclusion & Next Steps

Summary: Implemented custom version of portrait NST based on Selim et al., 2016 and extended work by including face-swapping
 Benchmarked against 2 implementations of Gatys et al, one implemented and one open source. Best results obtained from open-source
Next steps: Investigate additional masks and color transfer techniques as in open source, Implement 3D landmark estimation for face pose

3) G. Bradski. The OpenCV Library. Dr. Dobb's Journal of Software Tools, 2000