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 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.

### 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

### Methodology

**Gatys loss**

\[
L_{\text{Total}} = \sum_{i=1}^{L} a_i L_{\text{Style}}^i + \sum_{i=1}^{L} \beta_i L_{\text{Content}}^i
\]

Where:

\[
L_{\text{Content}}^i = \frac{1}{2N_i} \sum_j (F_i[A]_j - F_i[A^s]_j)^2
\]

and

\[
L_{\text{Style}}^i = \frac{1}{2N_i^2} \sum_j (F_i[A]_j F_i[A^s]_j^T - F_i[A^s] F_i[A]_j^T)^2
\]

**Selim adjustments to Gatys loss**

Replace \( F[A] \) in \( L_{\text{Style}} \) with \( F[A^s] \) \times G_{\text{Clamped}} \) where \( G \) is a gain map that enables transfer of local color distributions and is calculated as:

\[
G = \frac{F[A]}{(F[A] + \epsilon)} \quad \text{and} \quad G_{\text{Clamped}} = \max(\min(G, G_{\max}), G_{\min})
\]

### Results: hyper-parameter sweep

Convergence at ~300 steps

Parameter search show limited changes

Best results obtained with open-source\(^4\) implementation of Gatys

### 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 all, 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