



# Fast Patch-based Style Transfer of Arbitrary Style

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## ARTISTIC STYLE TRANSFER

Task: redrawing any photo in the style of any painting.

- Artists take days or months to create a painting.
- Can a computer transfer the style of an image onto another?

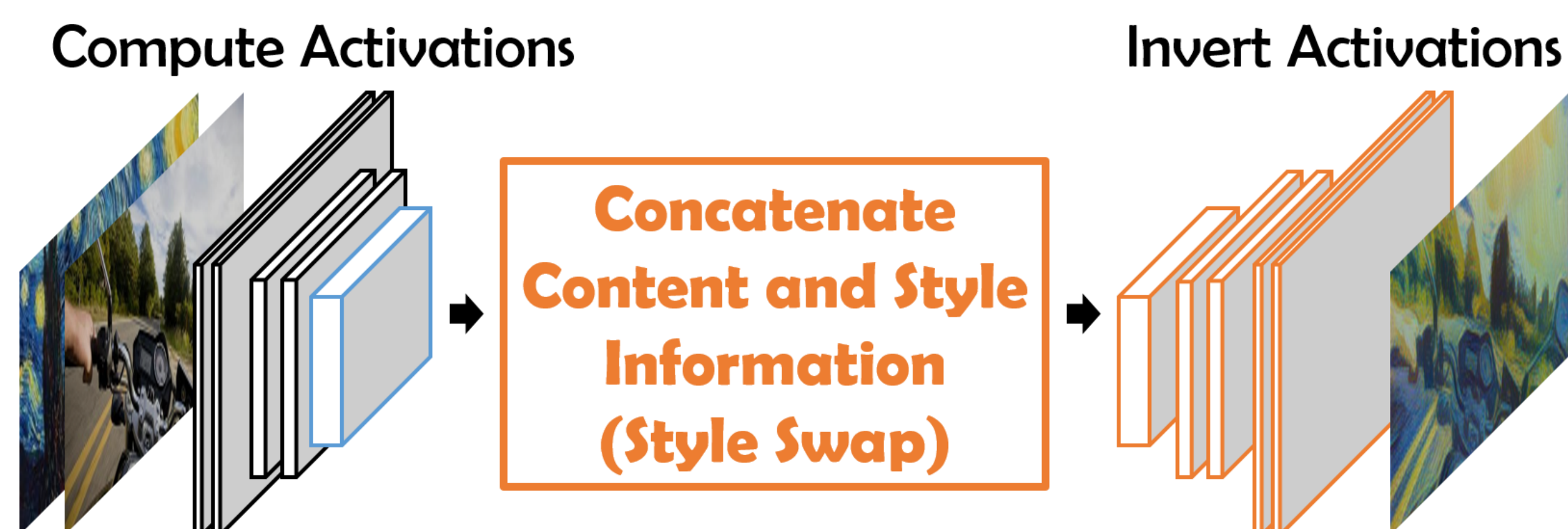


## INTRODUCTION

- The use of an **auxiliary pretrained CNN improves visual quality**.
- But the current approaches are either slow (optimization-based) or limited in the number of styles (trained style network).
- We present an approach that is both **efficient** and **adaptable to any style**.
- We train on 80,000 natural images and 80,000 paintings.

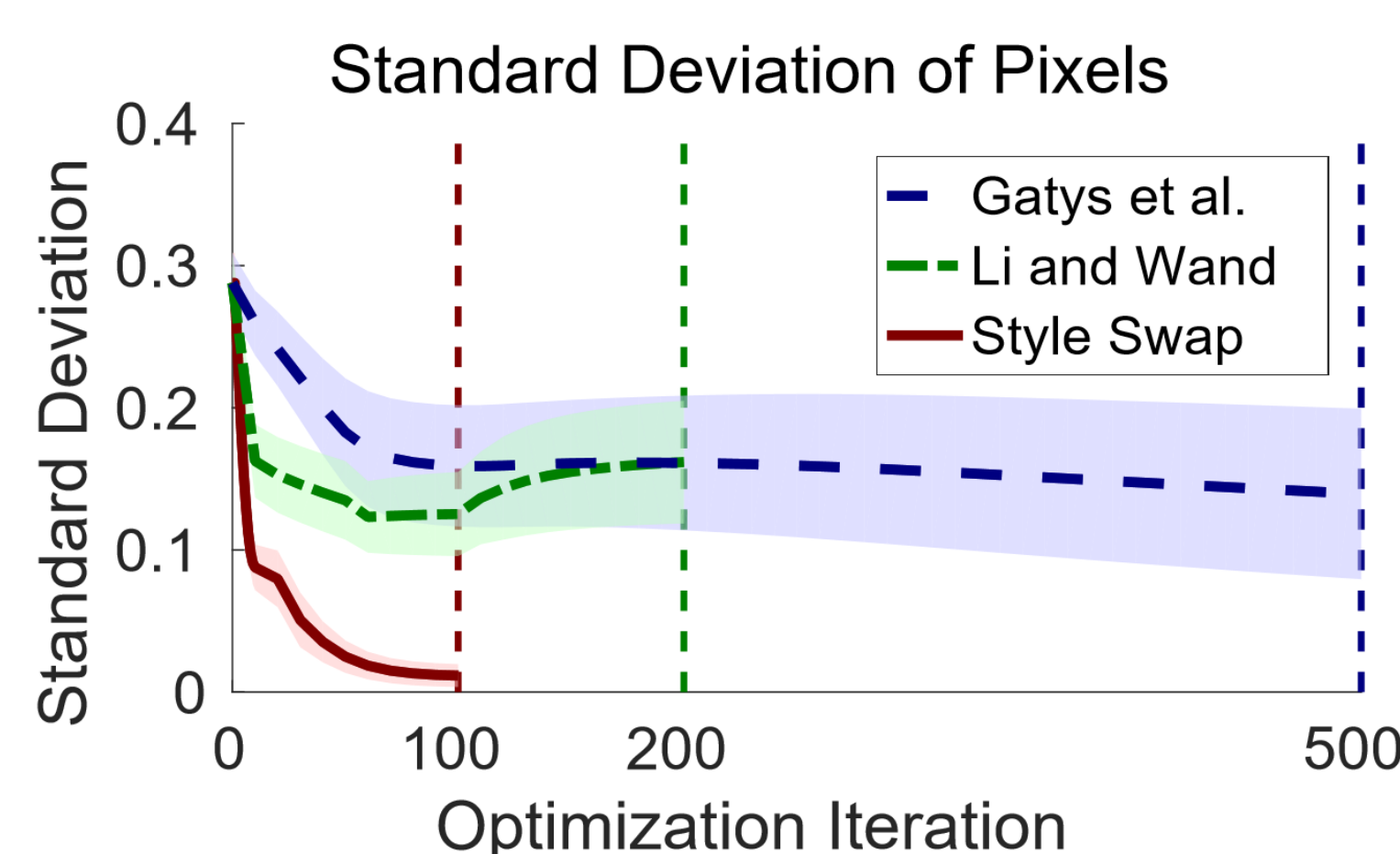
## OUR APPROACH

- We restrict to using only one layer of the pretrained CNN.
- We isolate the stylizing process inside its own module.
- The style-swapped activations can be **inverted** by either **optimization** or an **inverse network**.



## CONSISTENCY – FEW LOCAL OPTIMA

- Compared with other optimization approaches, our approach has much fewer local optima.
- Optimization procedure always converges to the same result.
- Allows consistent frame-by-frame performance on videos.



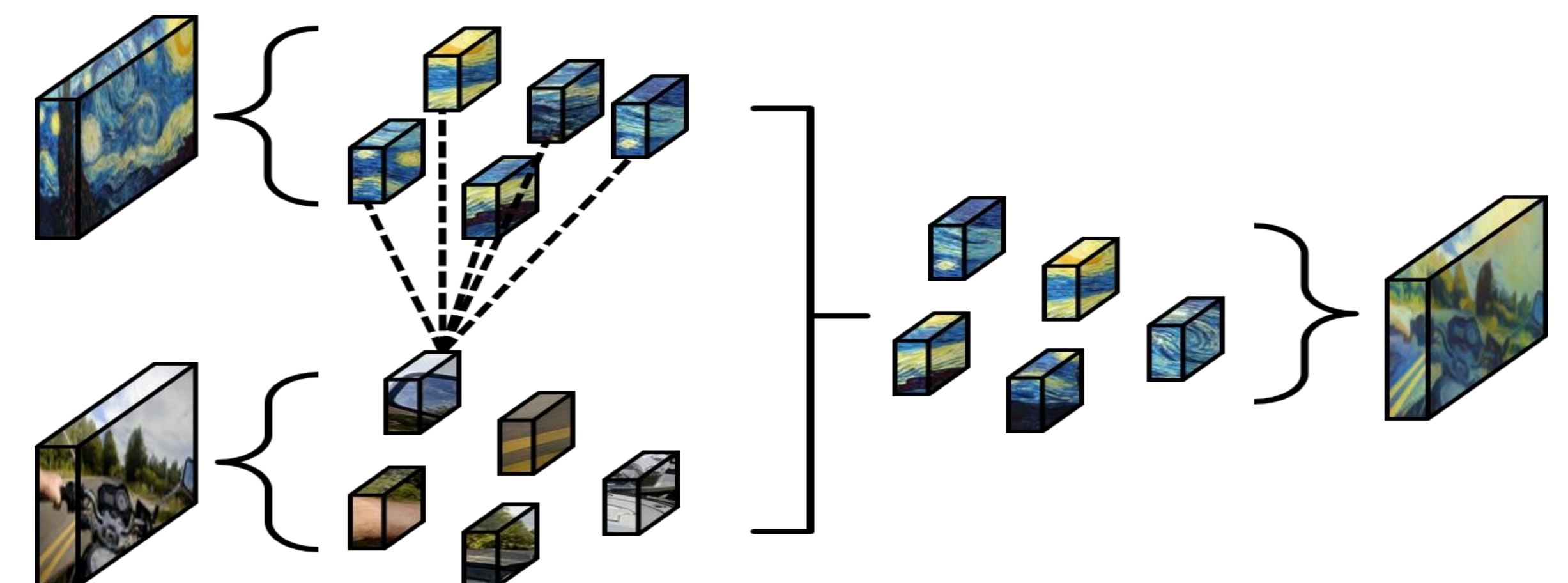
## SELECTED REFERENCES

- [1] L.A. Gatys, A.S. Ecker, and M. Bethge. *A Neural Algorithm of Artistic Style*.
- [2] C. Li and M. Wand. *Combining Markov Random Fields and Convolutional Neural Networks for Image Synthesis*. CVPR 2016.
- [3] J. Johnson, A. Alahi, L. Fei-Fei. *Perceptual Losses for Real-Time Style Transfer and Super-Resolution*. ECCV 2016.

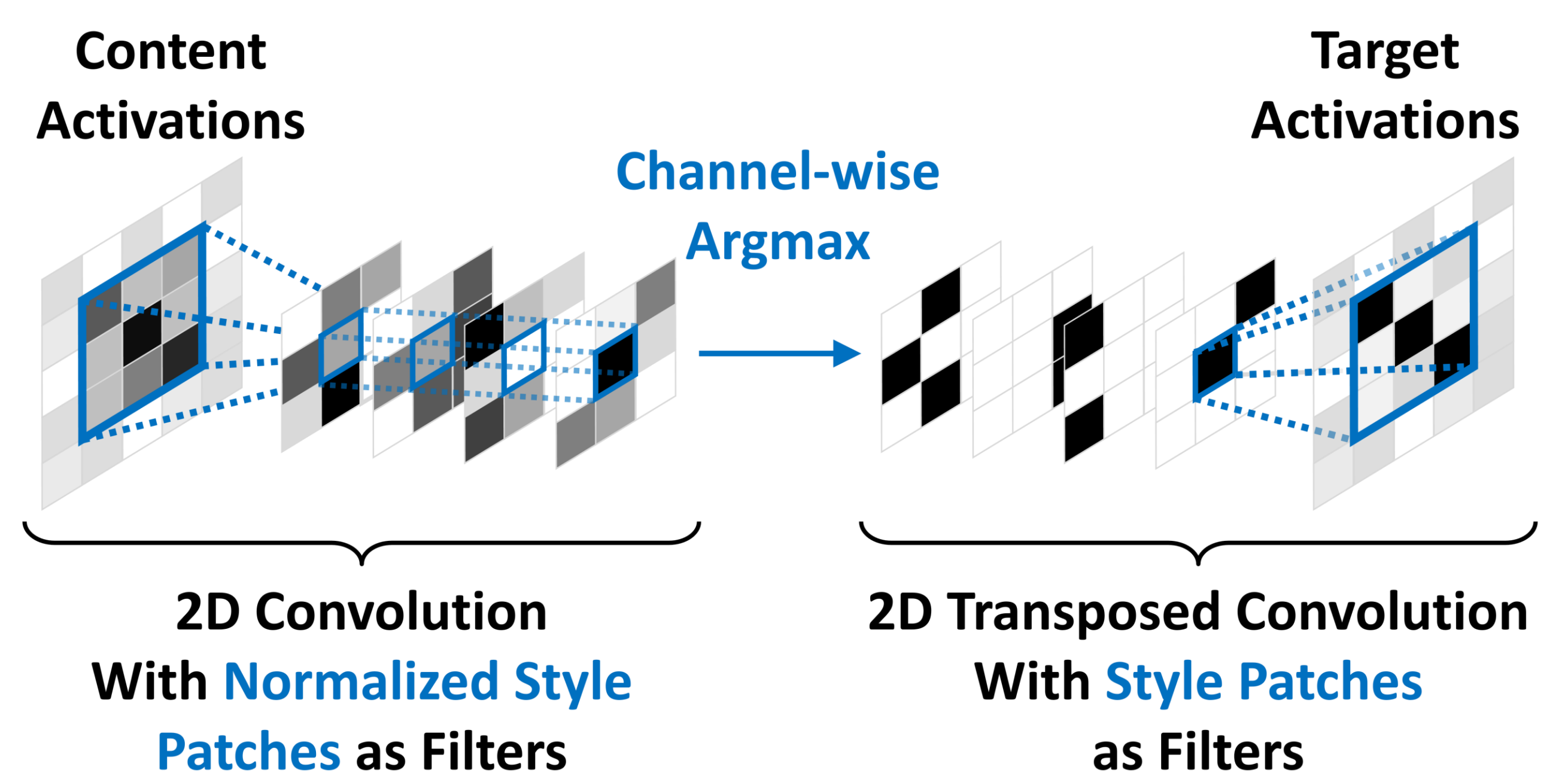
## STYLE SWAP : PATCH-BASED STYLE TRANSFER

For every content patch, **swap** it with the **best matching** style patch, which we define using the normalized cross-correlation:

$$\text{BestMatch}(c) = \arg \max_{s \in S} \frac{\langle c, s \rangle}{\|c\| \cdot \|s\|}$$



This operation can be **implemented efficiently** using a 2D convolutional layer and a 2D transposed convolutional layer.



## SIMPLE & INTUITIVE TUNING PARAMETER

Patch size of the style swap procedure is an **intuitive parameter** for changing the degree of abstraction.



## COMPUTATION TIME

Computation times where content and style images are 300x500.

Method	N. Iters.	Time/Iter. (s)	Total (s)
Gatys <i>et al.</i> [10]	500	0.1004	50.20
Li and Wand [19]	200	0.6293	125.86
Style Swap (Optim)	100	0.0466	4.66
Style Swap (InvNet)	1	1.2483	1.25

- The main bottleneck of our method is the style image size.
- Significant speedup can be achieved if the style image is small.