

# **Art Style Transfer Using Neural Networks**

**Ing. Laura Gregorc, MSc**  
**Virtual Vehicle Research GmbH**

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# Virtual Vehicle Research GmbH

## Automotive Data Science Team

Inffeldgasse 21a - 8010 Graz



**Laura Gregorc**

Data Scientist with Software  
Engineering Background



# Motivation

- Combine two images
- Generate new content image with given style



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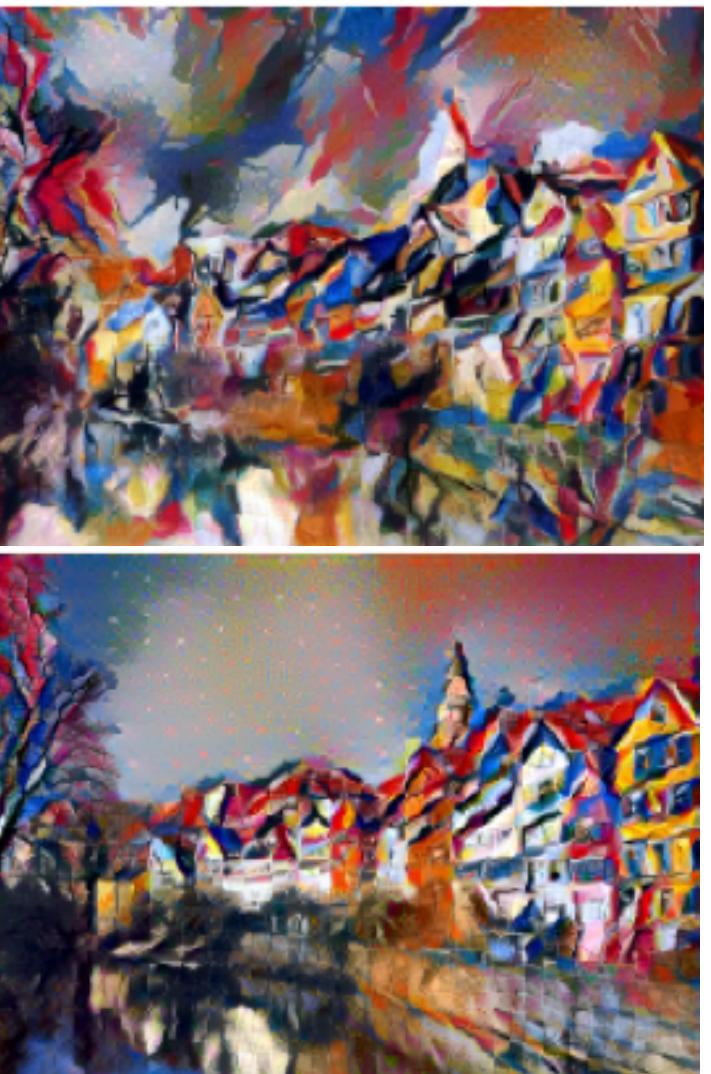
<https://github.com/gargimahale/Doodle>

# Theory

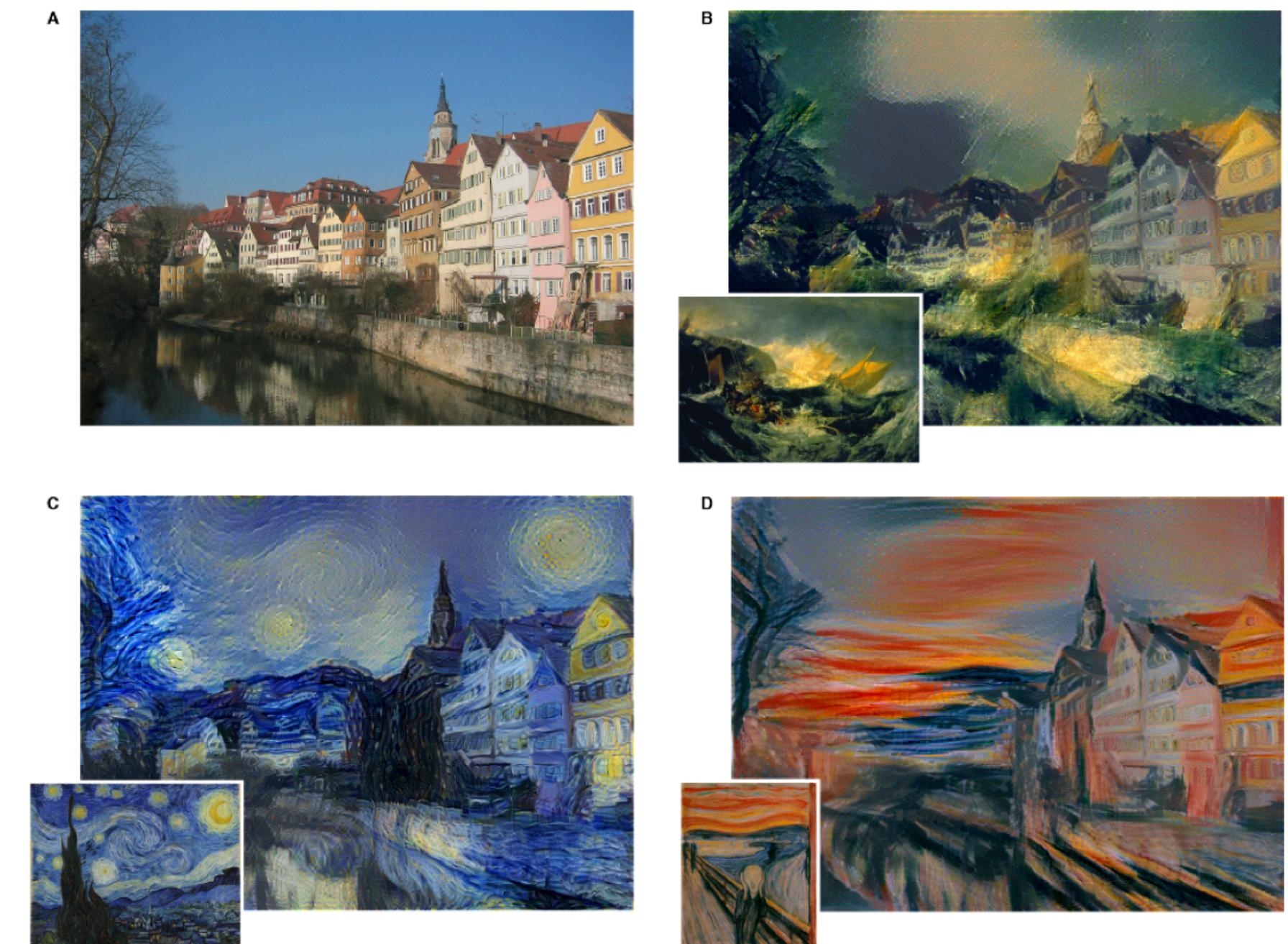
Gatys, Leon, et al. "A Neural Algorithm of Artistic Style." *Journal of Vision*, vol. 16, no. 12, Sept. 2016, p. 326. Crossref: <https://doi.org/10.1167/16.12.326>.

$$\mathcal{L}_{total}(\vec{p}, \vec{a}, \vec{x}) = \underline{\alpha} \underline{\mathcal{L}_{content}}(\vec{p}, \vec{x}) + \underline{\beta} \underline{\mathcal{L}_{style}}(\vec{a}, \vec{x})$$

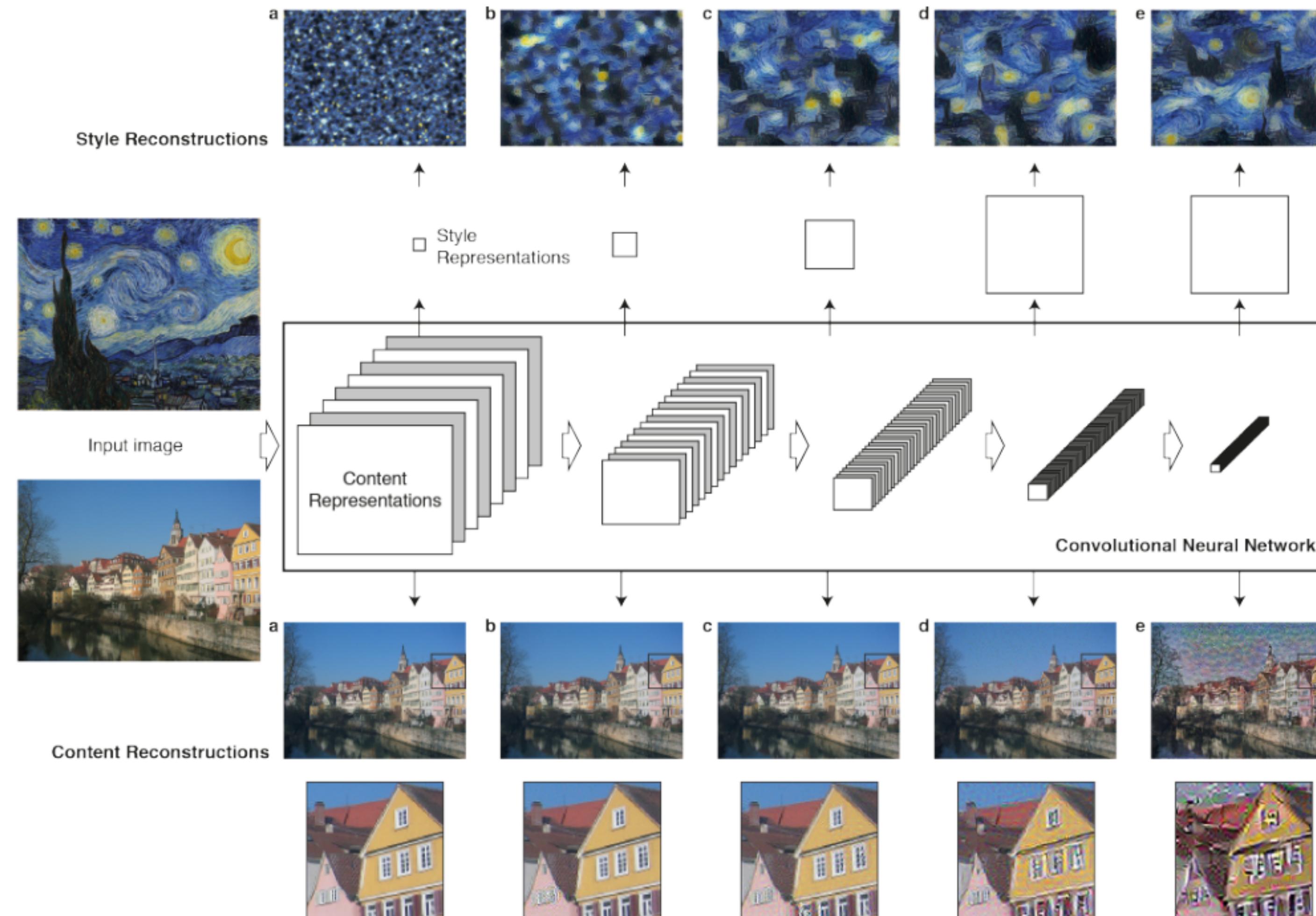
- Images
- Weights



$$= \begin{matrix} 100 * \\ 10.000 * \end{matrix}$$

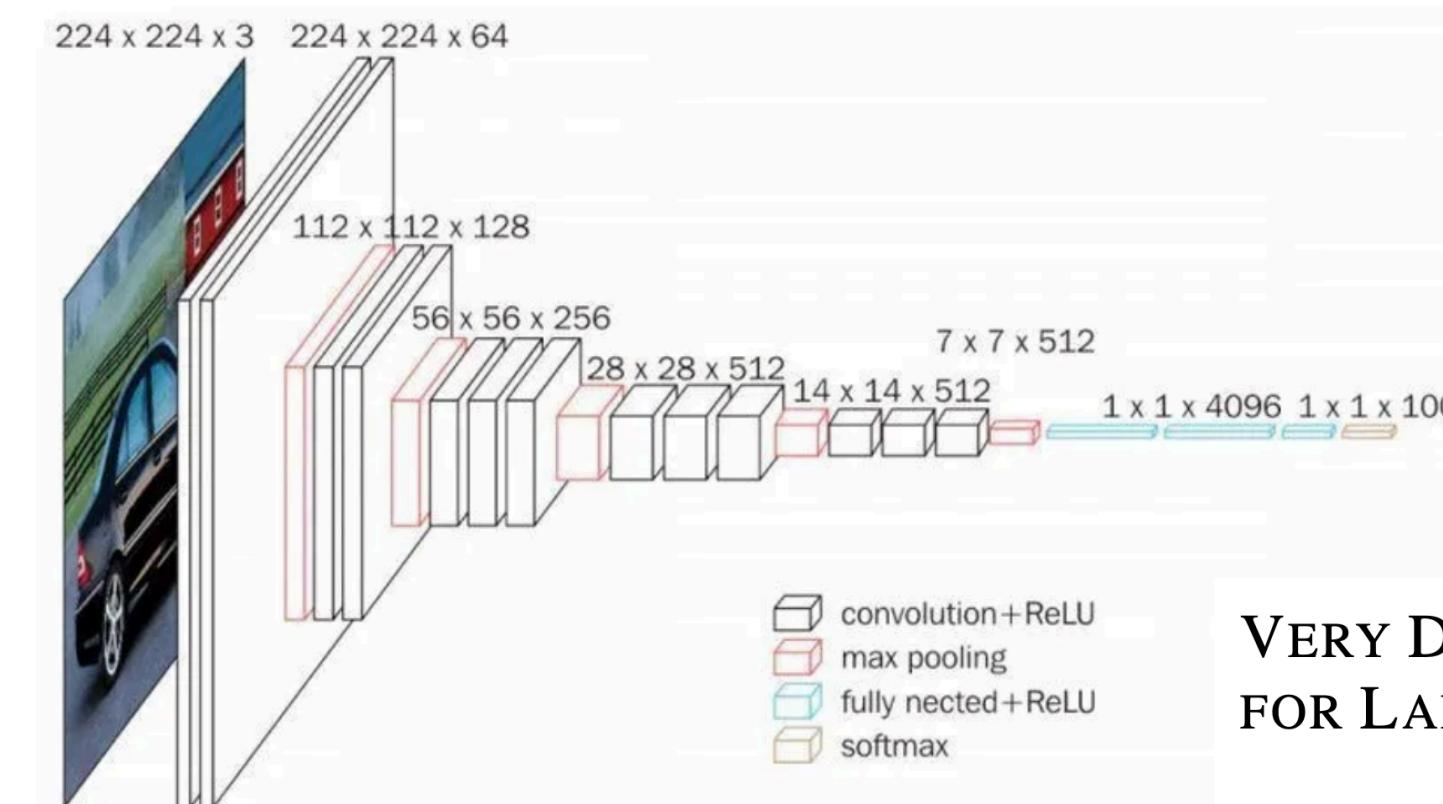
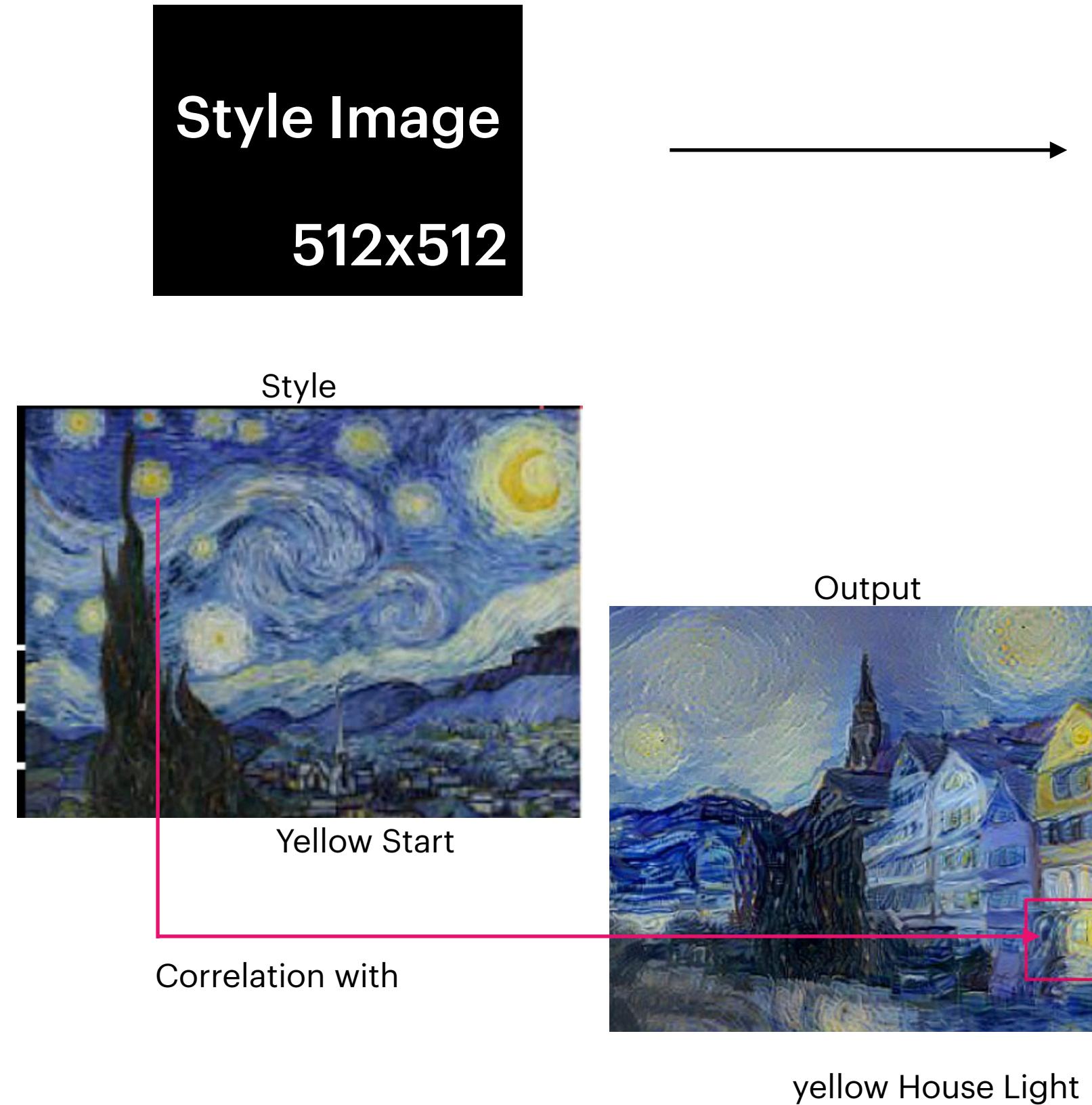


# CNN processing



# Style Loss

## VGG19 Pre-Trained Model



VERY DEEP CONVOLUTIONAL NETWORKS  
FOR LARGE-SCALE IMAGE RECOGNITION

Karen Simonyan\* & Andrew Zisserman<sup>†</sup>  
Visual Geometry Group, Department of Engineering Science, University of Oxford  
[{karen,az}@robots.ox.ac.uk](mailto:{karen,az}@robots.ox.ac.uk)

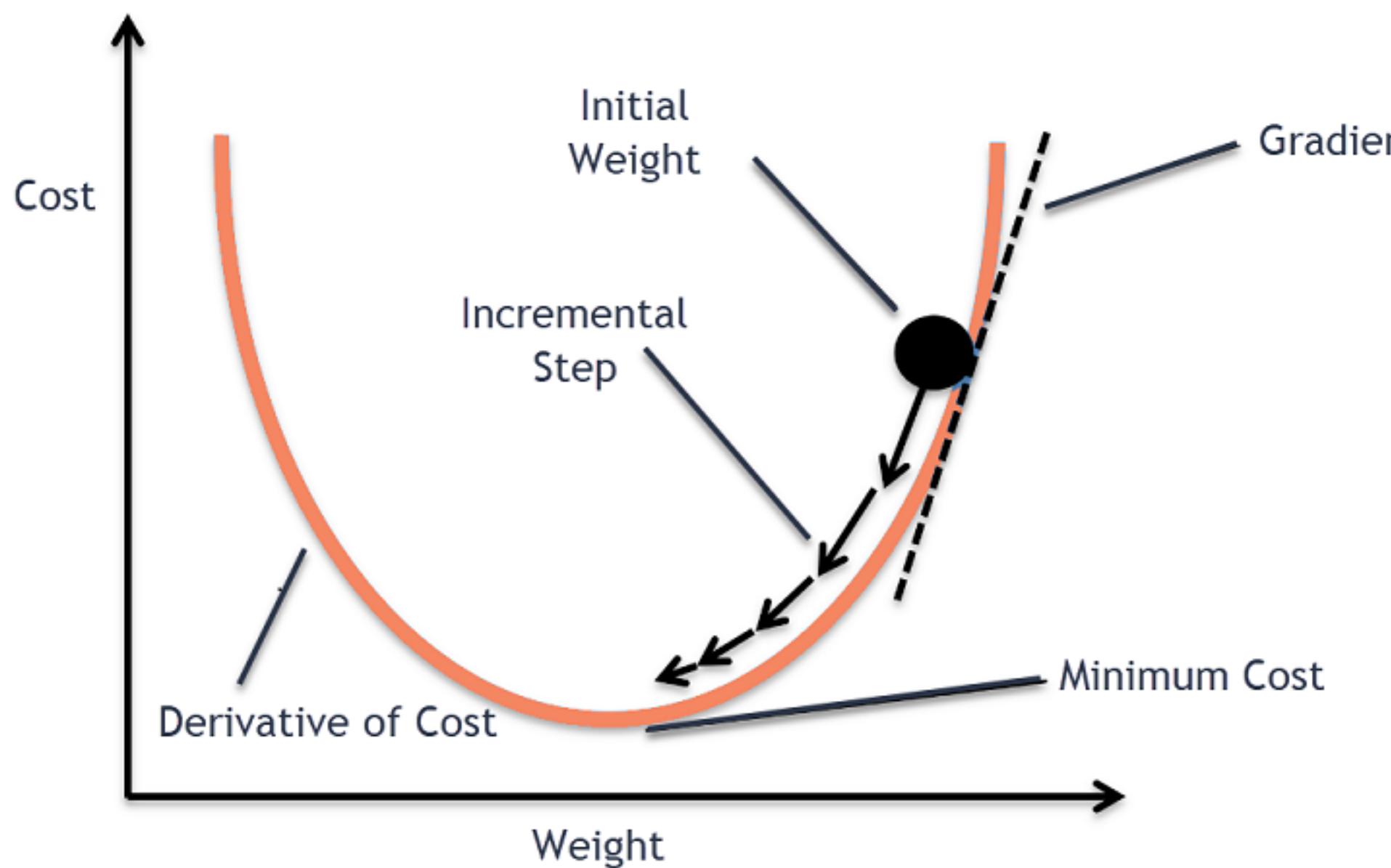
Feature maps (Curves, Edges,...)

Gram matrix  
Correlations

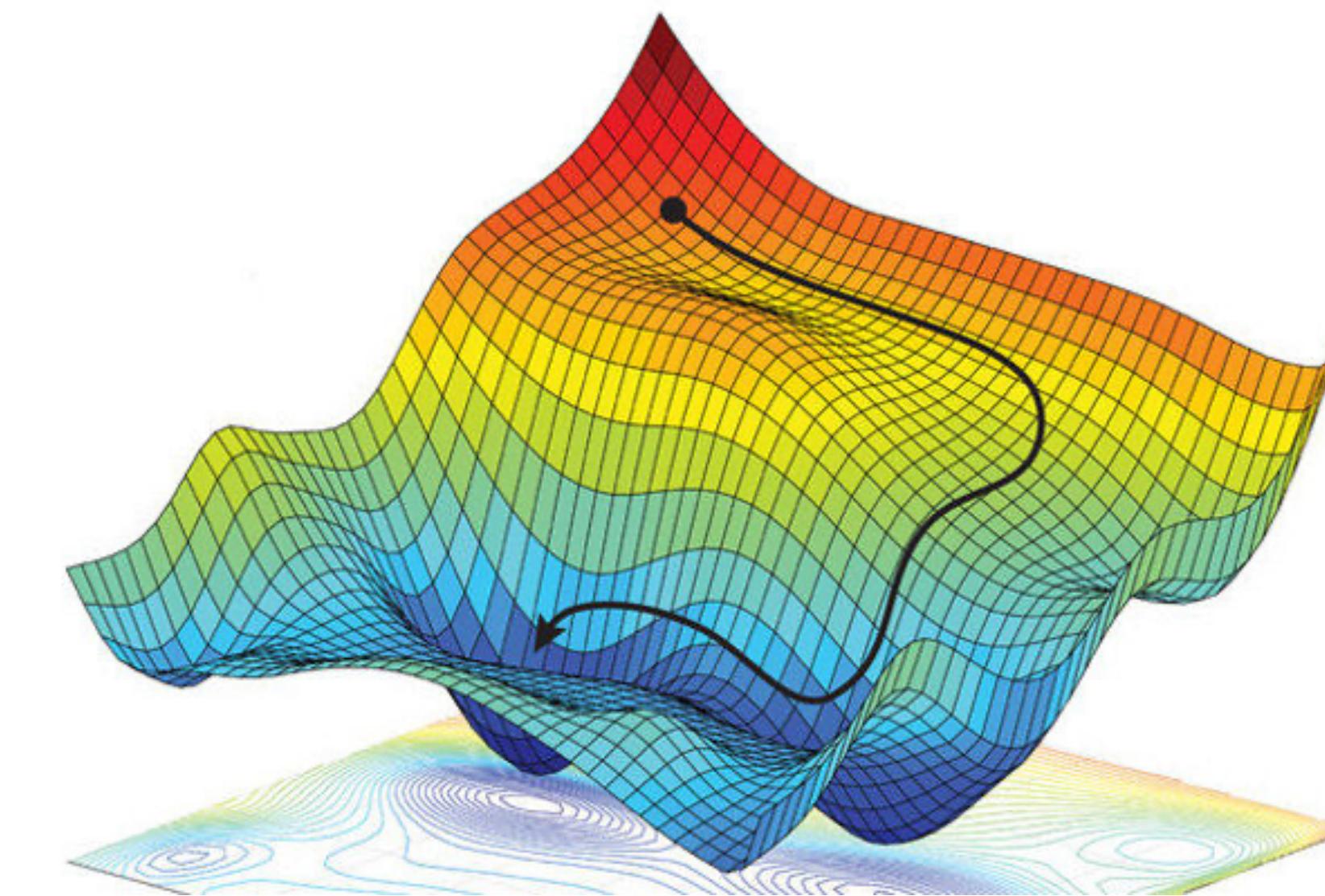
Important  
Texture of  
Style Image

# Gradient Descent

- Search for best combination of weights in a CNN



[https://editor.analyticsvidhya.com/uploads/631731\\_P7z2BKhdOR-9uyn9ThDasA.png](https://editor.analyticsvidhya.com/uploads/631731_P7z2BKhdOR-9uyn9ThDasA.png)



<https://www.researchgate.net/publication/325142728/figure/fig1/AS:766109435326465@1559666131320/Non-convex-optimization-We-utilize-stochastic-gradient-descent-to-find-a-local-optimum.jpg>

# **Art Style Transfer**

## **Main Steps**

- Load Style & Content images
- Pass through VGG19 network to extract representations
- Define loss functions for Style & Content individually
- Initial image and iterate by minimizing loss function using gradient decent
- Stop when combination of Style & Content is sufficient

[github.com/lauragregorc/ArtsyNN](https://github.com/lauragregorc/ArtsyNN)

**Implementation & Tryout**

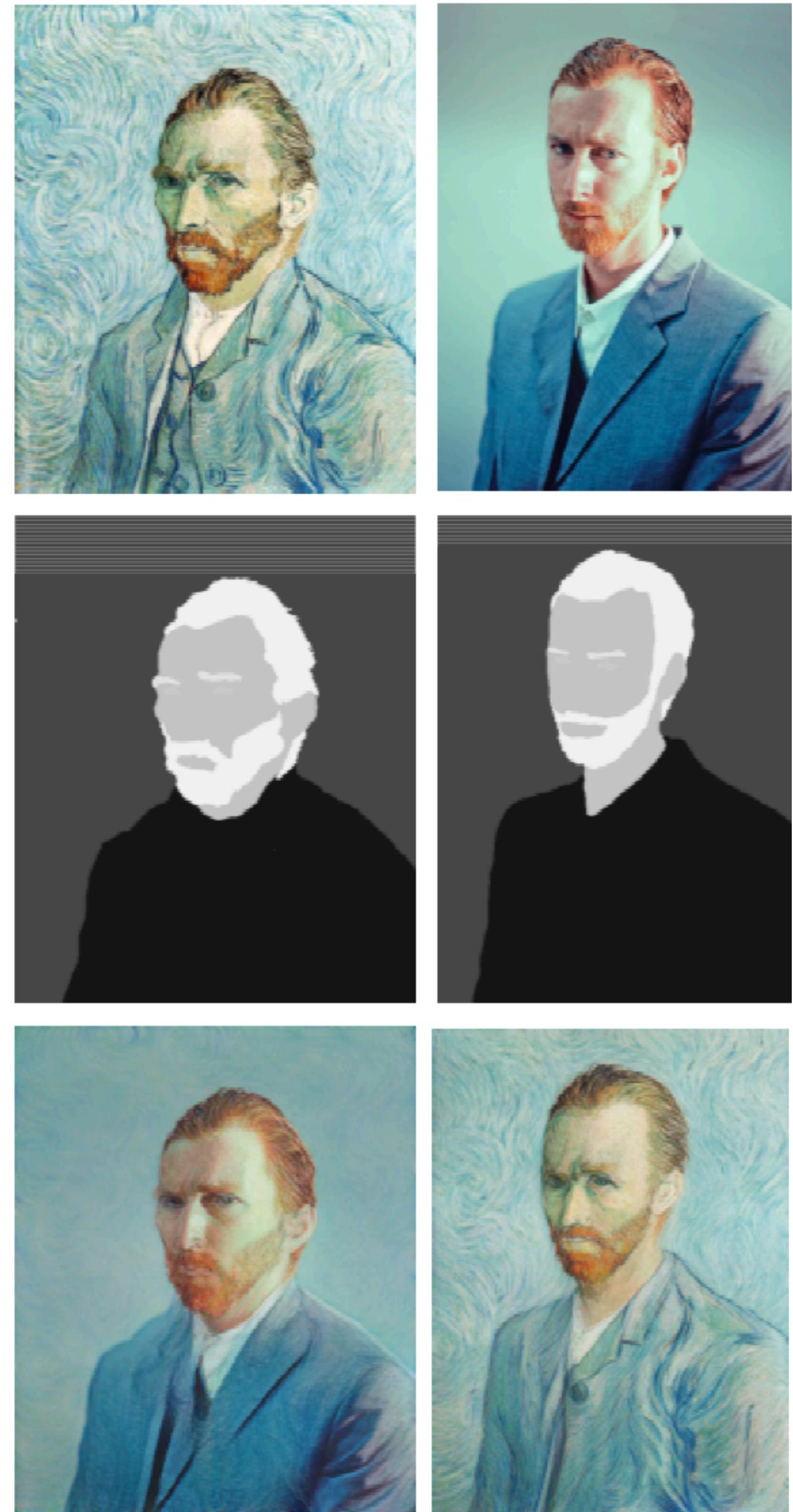
# Advanced Method

Champandard, Alex J. "Semantic style transfer and turning two-bit doodles into fine artworks." *arXiv preprint arXiv:1603.01768* (2016).

- Add semantic map of images
- Classes of Areas
- Better understanding of different areas in a image

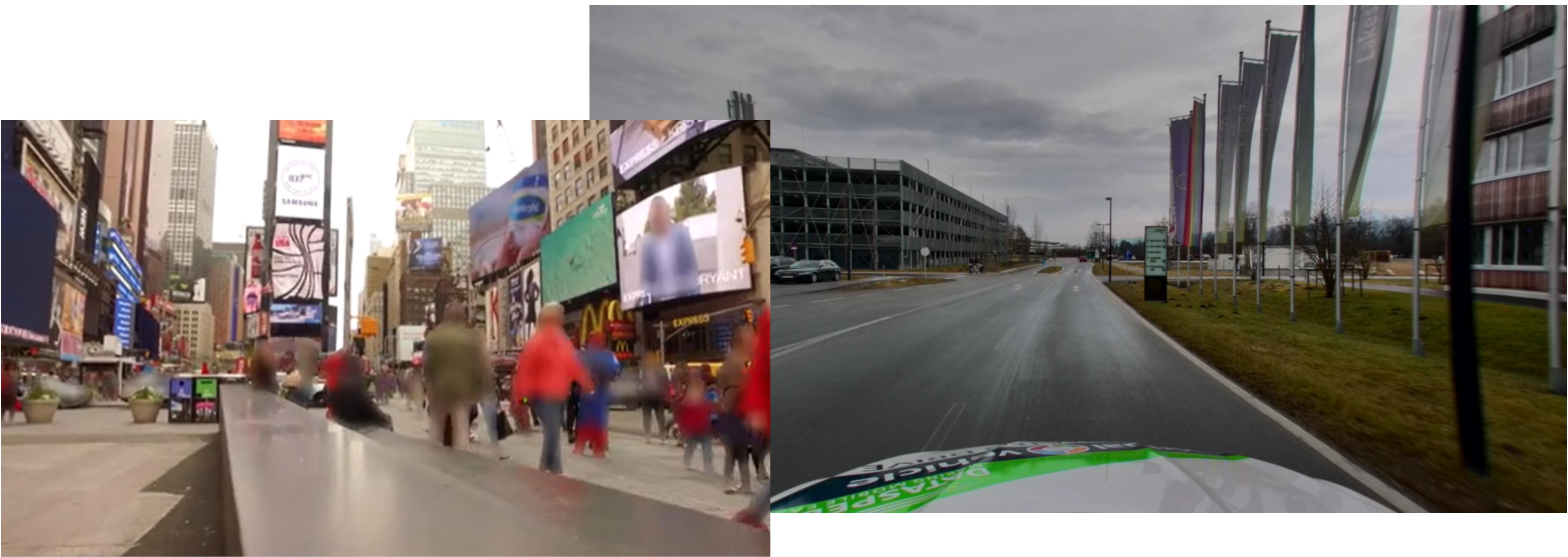
Example in git repository or

<https://github.com/alexjc/neural-doodle>



# Usage in Projects

- Anonymization of pedestrians while using autonomous vehicles
- Generate synthetic test/training data for ai models



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