




# Stereoscopic Style Transfer

Kunst ist das, was man sieht




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parrotsonjava.com

**Thomas Endres**

 @originalone1984

# Edgar Degas



*"Art is not  
what*



*if you  
make others see."*



# What is this all about?





# Hardware Hacking Team

TNG Technology Consulting GmbH



Jonas Mayer



Thomas Endres



Martin Förtsch



Thomas Reifenberger



Florian Gather



Markus Spanier



Christoph Bergemann



Holger Frydrich



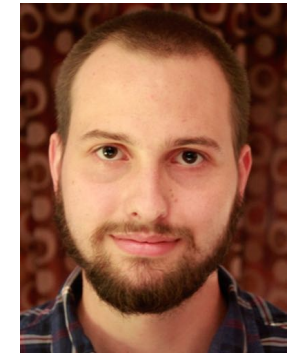
Mathias Arens



Andreas Würll



Mirco Michel



Leopold Kellers



# Agenda

- Introduction
- Deep Learning in a Nutshell
- Style Transfer
- Code & Technology



# Retrospection

## Augmented Rift (2015)





# Retrospection

## Augmented Rift (2015)







# Introduction

## Style Transfer



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1. Von Vincent van Gogh - bgEuwDxel93-Pg at Google Cultural Institute, zoom level maximum, Gemeinfrei, <https://commons.wikimedia.org/w/index.php?curid=25498286>  
2. Photo by Martin Förtsch, "Window to the World", Mesa Arch, Canyonlands, 2015

# Introduction

## Style Transfer

source image content



source image style



output image





# Introduction

## Style Transfer



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1. Edvard Munch - WebMuseum at ibiblioPage URL: <http://www.ibiblio.org/wm/paint/auth/munch/munch.scream.jpg>, Gemeinfrei, <https://commons.wikimedia.org/w/index.php?curid=37610298>

# Introduction

## Style Transfer



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1. Pablo Picasso, Frau mit grünem Hut, [https://www.albertina.at/site/assets/files/1456/9\\_pablo\\_picasso\\_-\\_frau\\_mit\\_gruenem\\_hut.720x0.jpg](https://www.albertina.at/site/assets/files/1456/9_pablo_picasso_-_frau_mit_gruenem_hut.720x0.jpg)

# Introduction

DeepArt.io

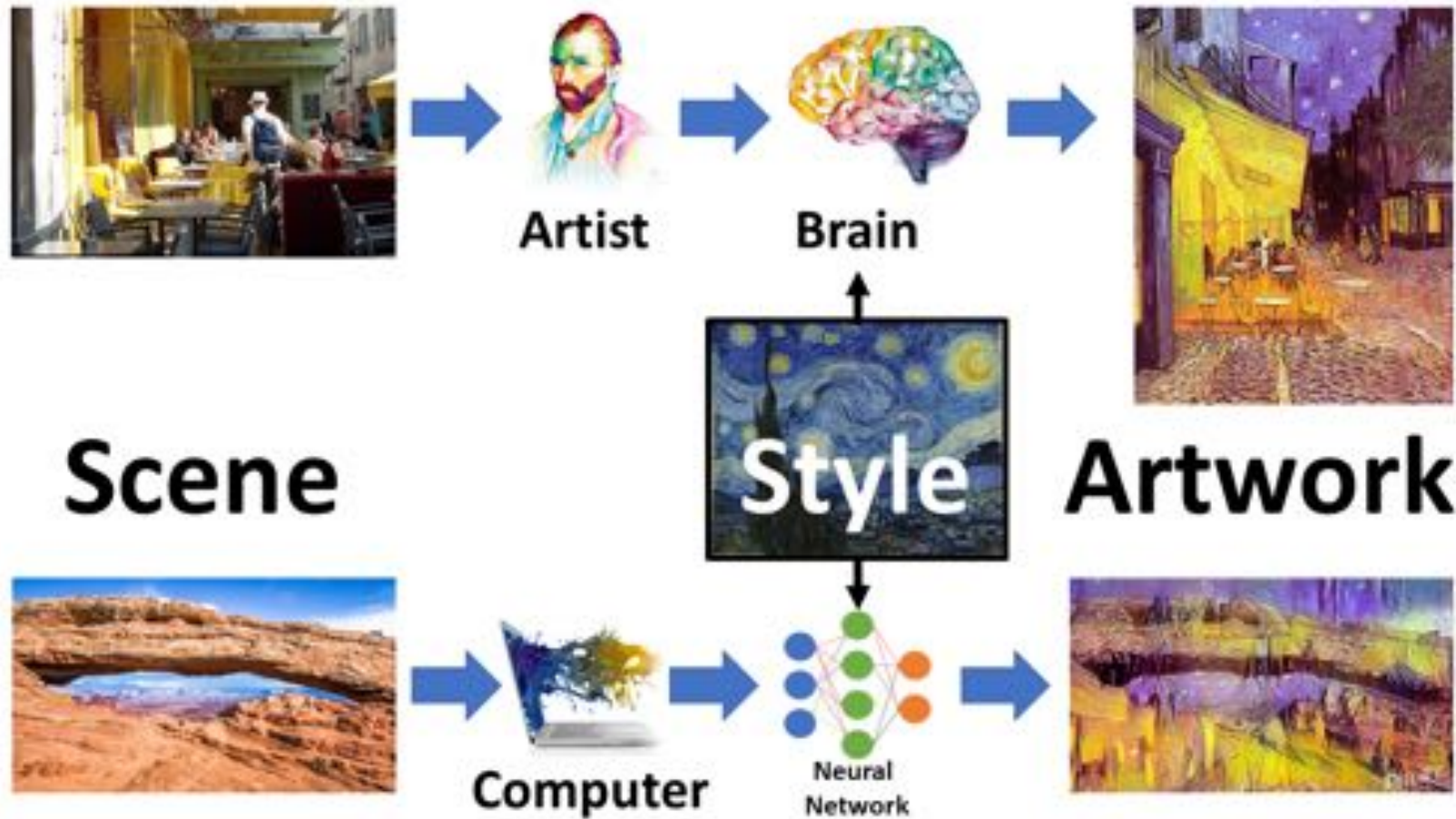
DEEPART.io





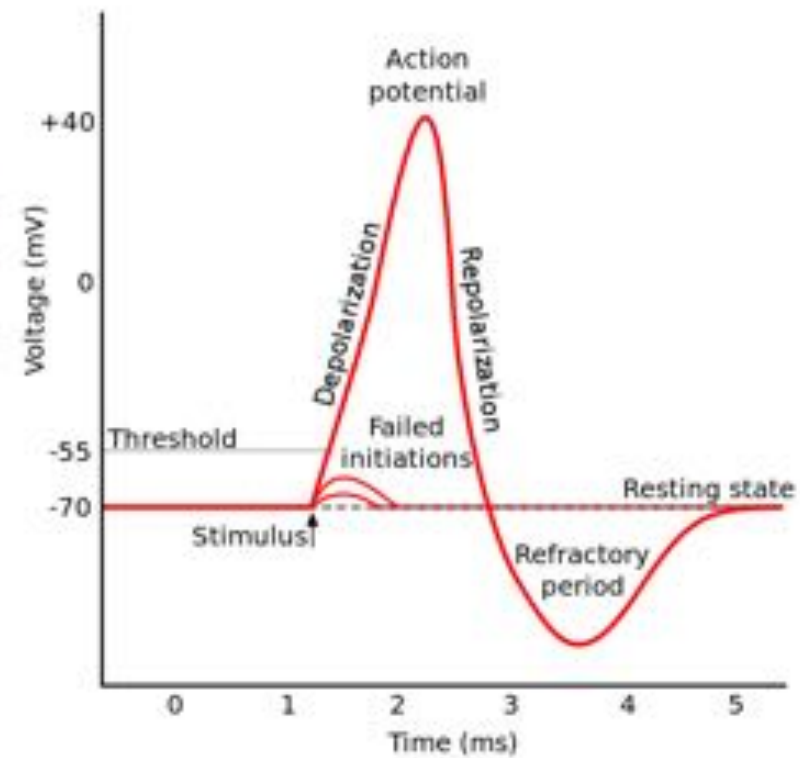
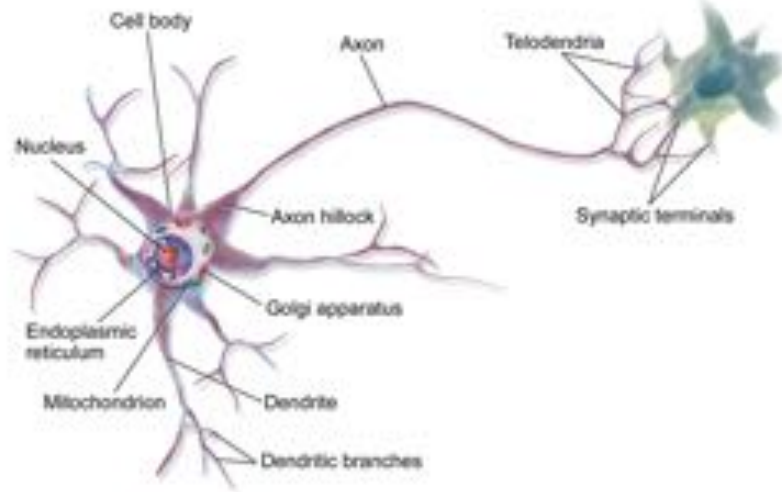
# Introduction

## How Paintings work



# Introduction

## Deep Learning in a Nutshell



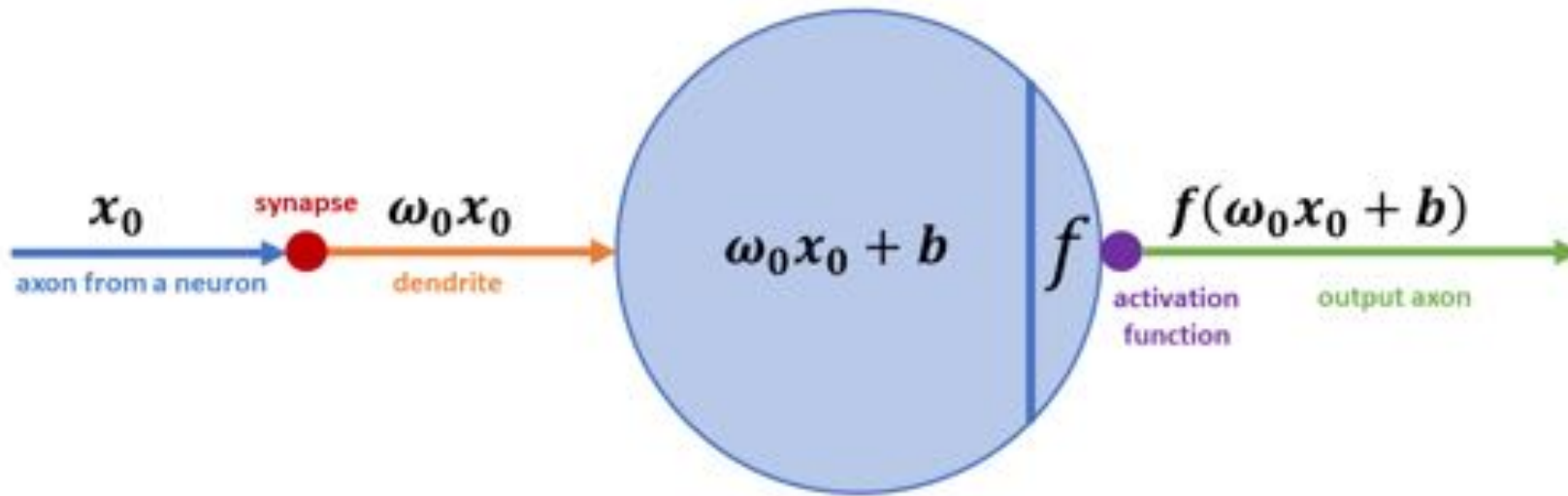
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# Introduction

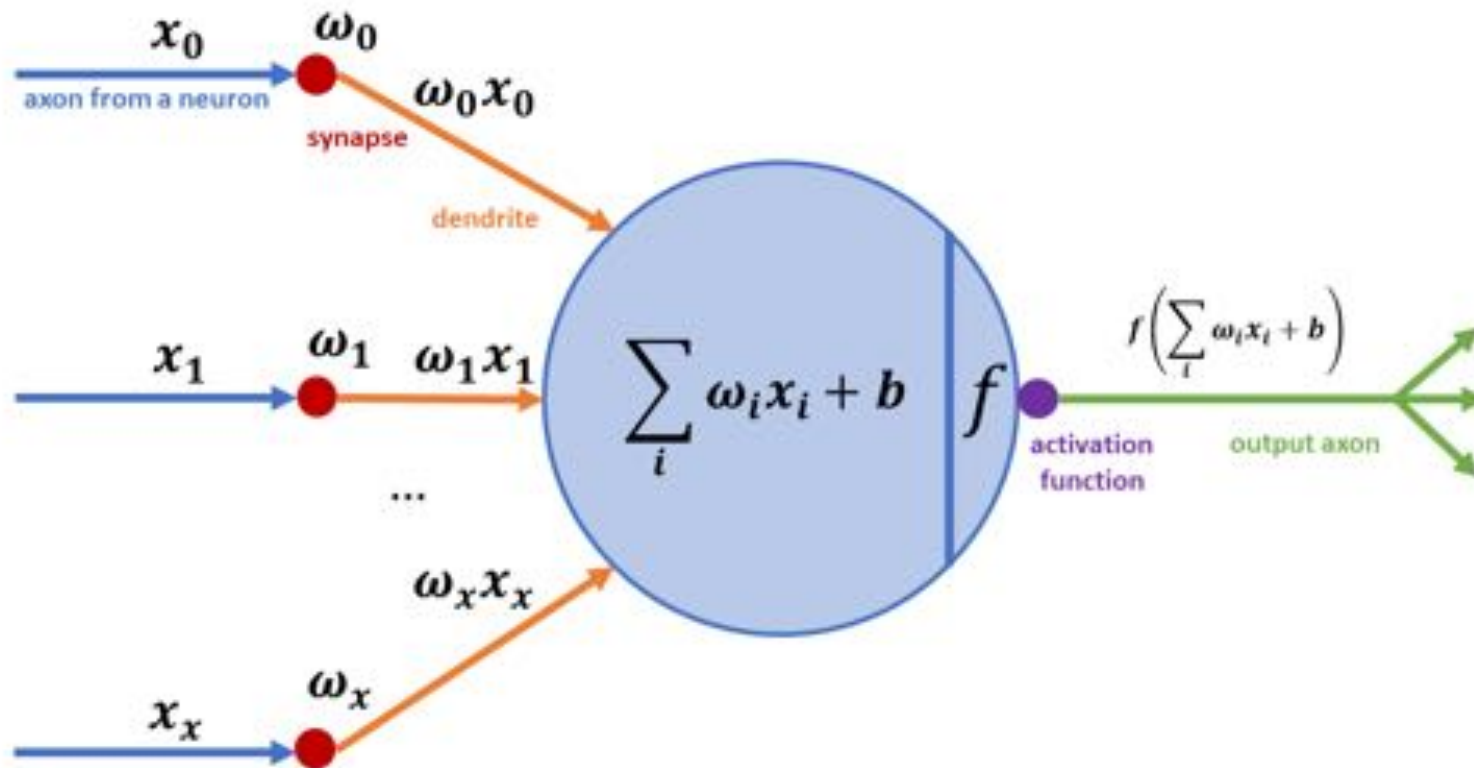
## Deep Learning in a Nutshell





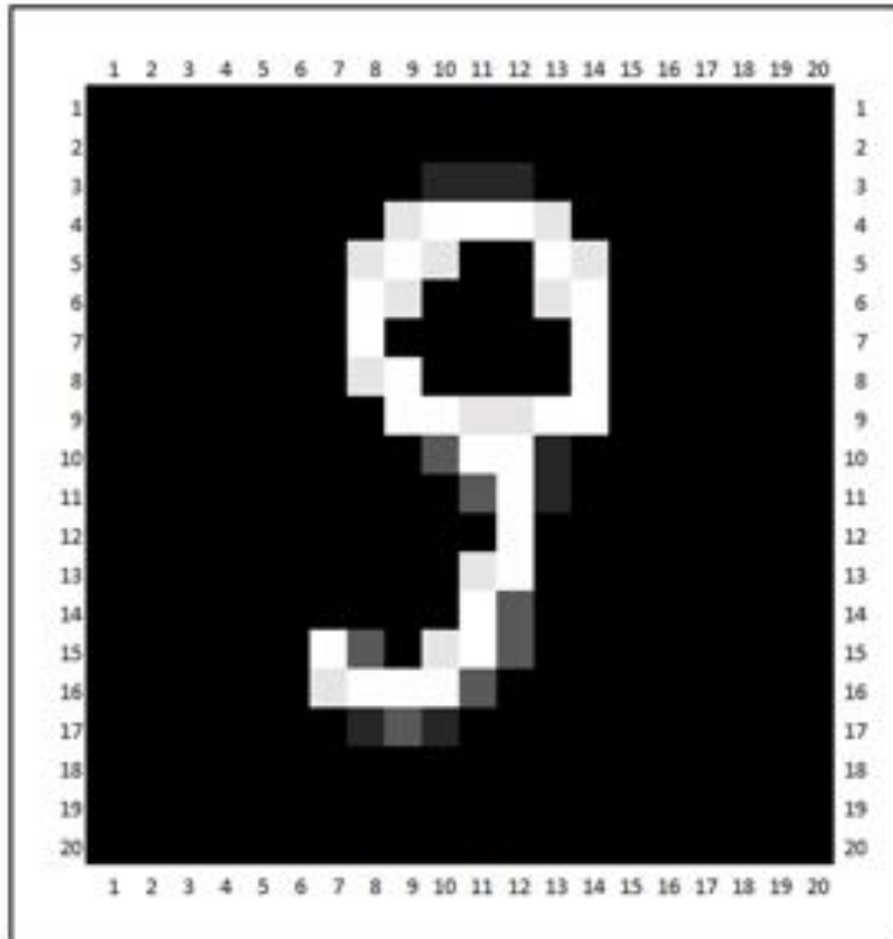
# Introduction

## Deep Learning in a Nutshell



# Introduction

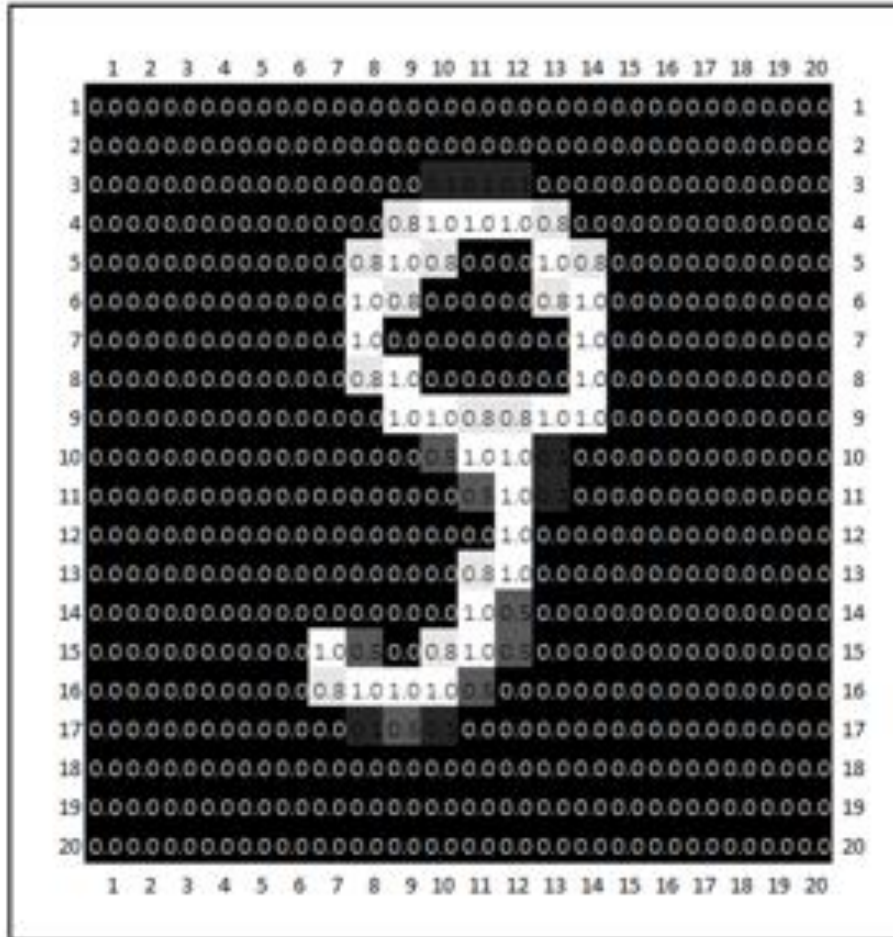
## Deep Learning in a Nutshell





# Introduction

## Deep Learning in a Nutshell



Grayscale  
Color

„Activation“

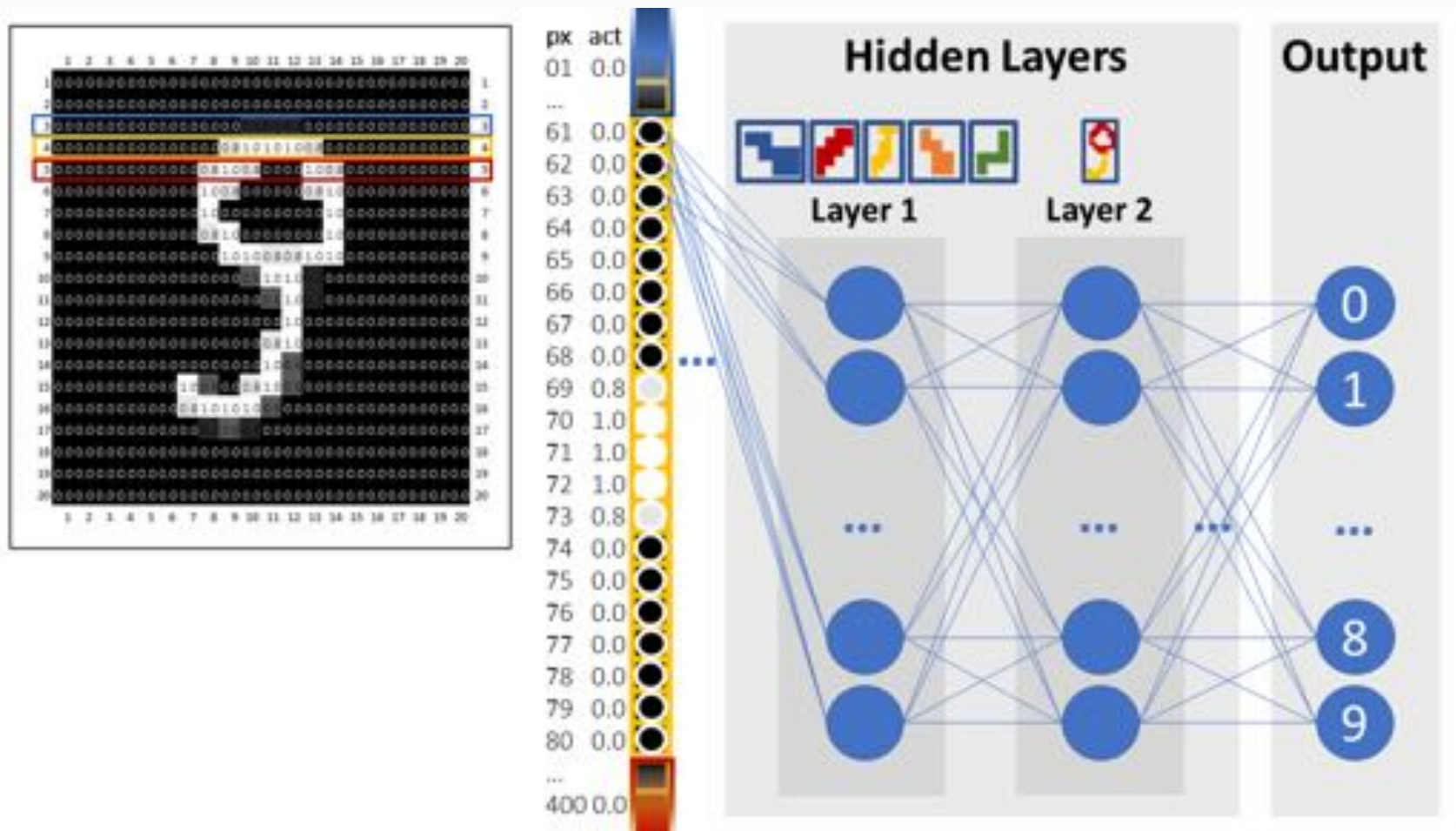


1.0  
0.8  
0.5  
0.1  
0.0



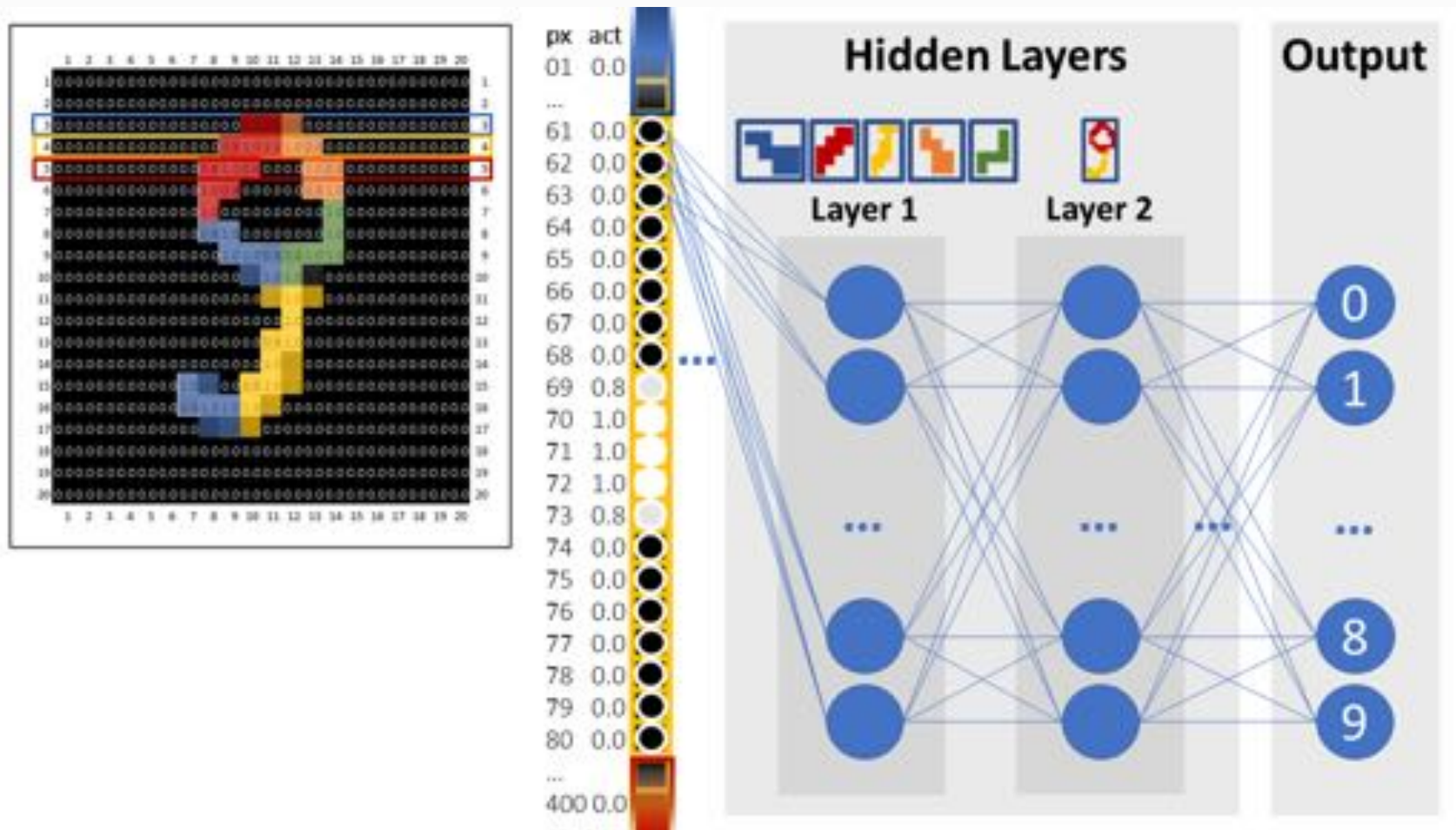
# Introduction

## Deep Learning in a Nutshell



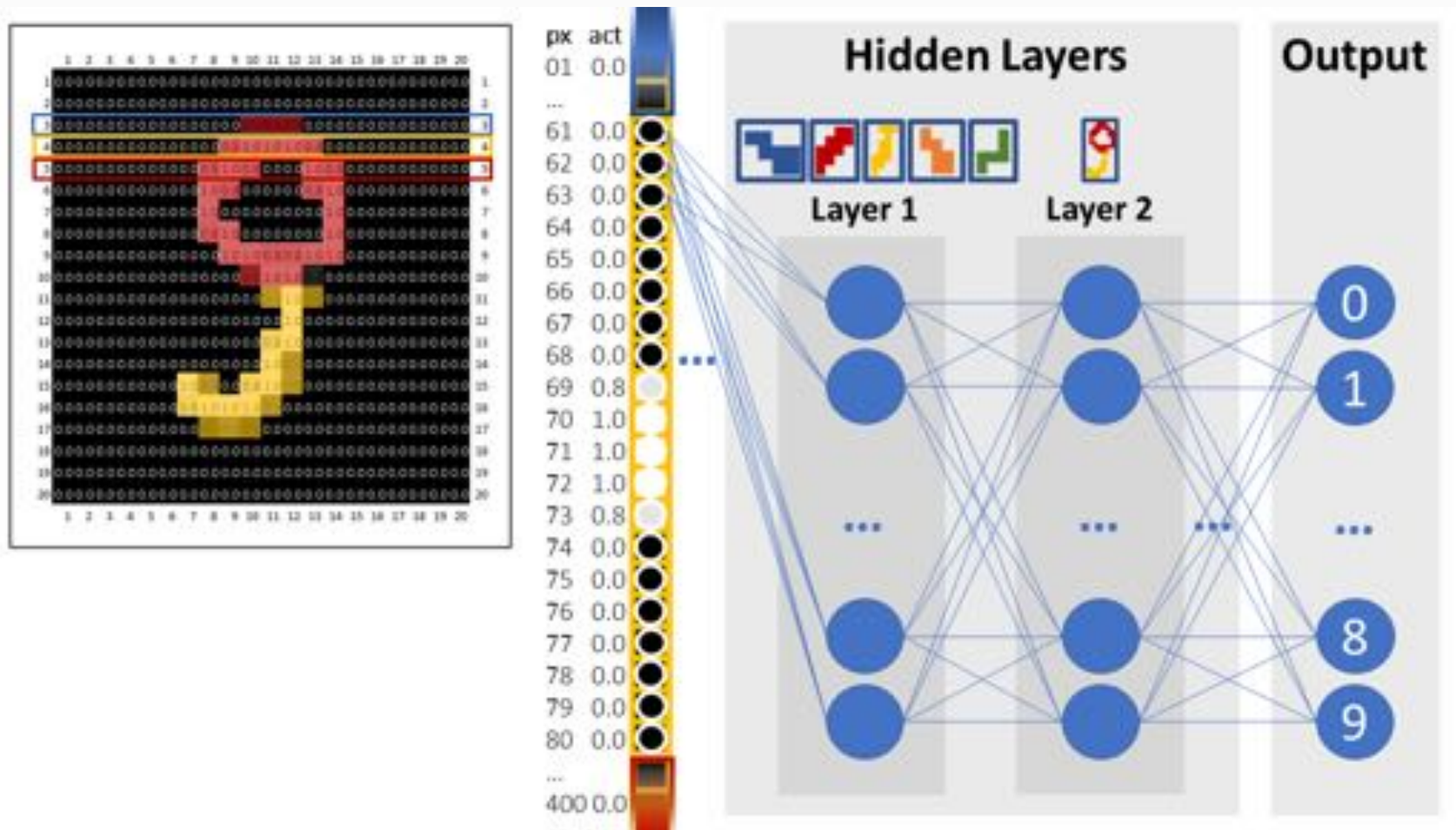
# Introduction

## Deep Learning in a Nutshell



# Introduction

## Deep Learning in a Nutshell



# Introduction

## Deep Learning in a Nutshell







# Introduction

## Deep Learning in a Nutshell

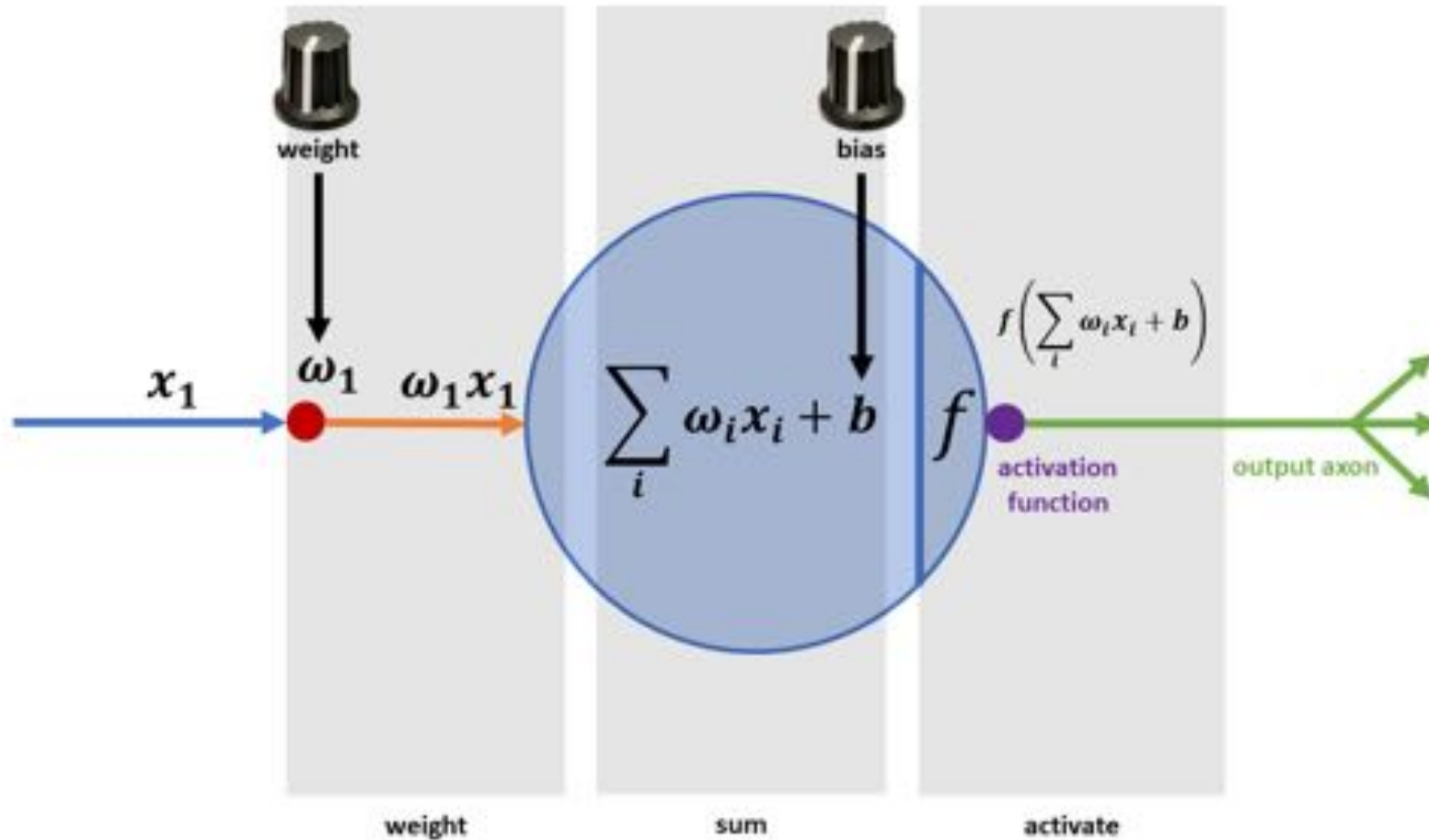


Gussed	Activation	Correct	Activation
0	0,2	0	0,0
1	0,2	1	0,0
2	0,0	2	0,0
3	0,7	3	0,0
4	0,0	4	0,0
5	0,2	5	0,0
6	0,2	6	0,0
7	0,0	7	0,0
8	0,9	8	0,0
9	0,5	9	1,0

$$\left[ \begin{array}{l} (0,2 - 0,0)^2 + \\ (0,2 - 0,0)^2 + \\ (0,0 - 0,0)^2 + \\ (0,7 - 0,0)^2 + \\ (0,0 - 0,0)^2 + \\ (0,2 - 0,0)^2 + \\ (0,2 - 0,0)^2 + \\ (0,0 - 0,0)^2 + \\ (0,9 - 0,0)^2 + \\ (0,5 - 1,0)^2 \end{array} \right] = 1,71$$

# Introduction

## Deep Learning in a Nutshell



# Introduction

## Deep Learning in a Nutshell



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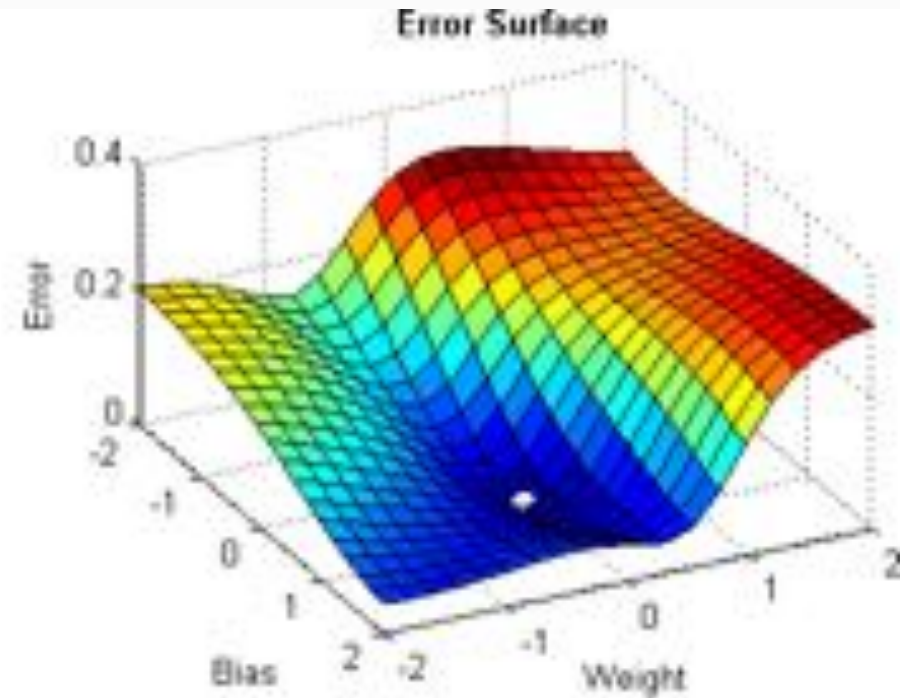
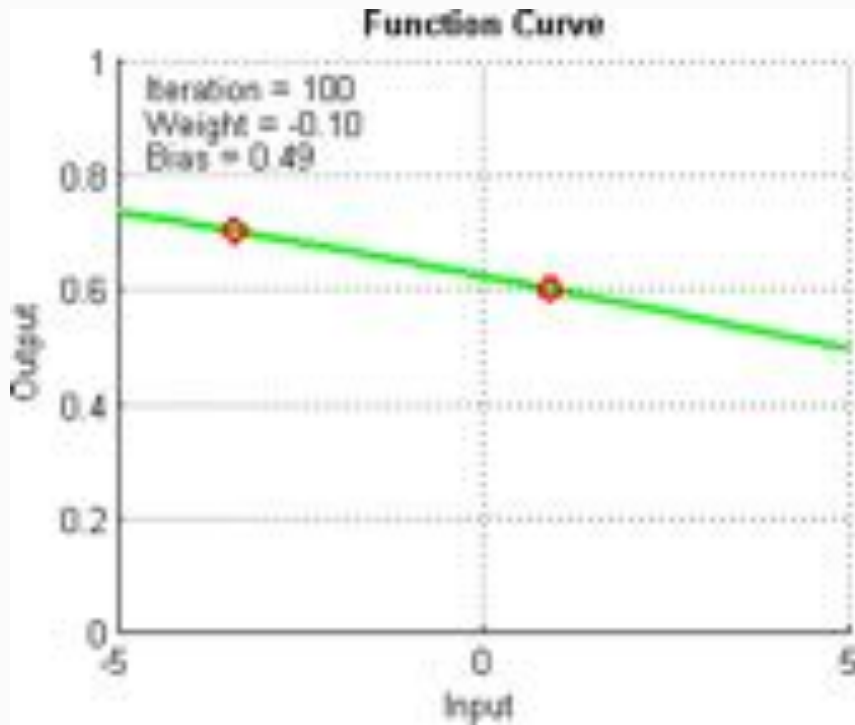
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1. By JacoTen [CC BY-SA 3.0 (<https://creativecommons.org/licenses/by-sa/3.0/>)], from Wikimedia Commons



# Introduction

## Deep Learning in a Nutshell



# Introduction

## Deep Learning in a Nutshell



# Introduction

## Deep Learning in a Nutshell



Gussed	Correct
0 0,0	0 0,0
1 0,0	1 0,0
2 0,0	2 0,0
3 0,1	3 0,0
4 0,0	4 0,0
5 0,0	5 0,0
6 0,2	6 0,0
7 0,0	7 0,0
8 0,1	8 0,0
9 0,9	9 1,0

$$\left[ \begin{array}{l} (0,0 - 0,0)^2 + \\ (0,0 - 0,0)^2 + \\ (0,0 - 0,0)^2 + \\ (0,1 - 0,0)^2 + \\ (0,0 - 0,0)^2 + \\ (0,0 - 0,0)^2 + \\ (0,2 - 0,0)^2 + \\ (0,0 - 0,0)^2 + \\ (0,1 - 0,0)^2 + \\ (0,9 - 1,0)^2 \end{array} \right] = 0,07$$



# Style Transfer

## Offline Role Play Game (Content Image)



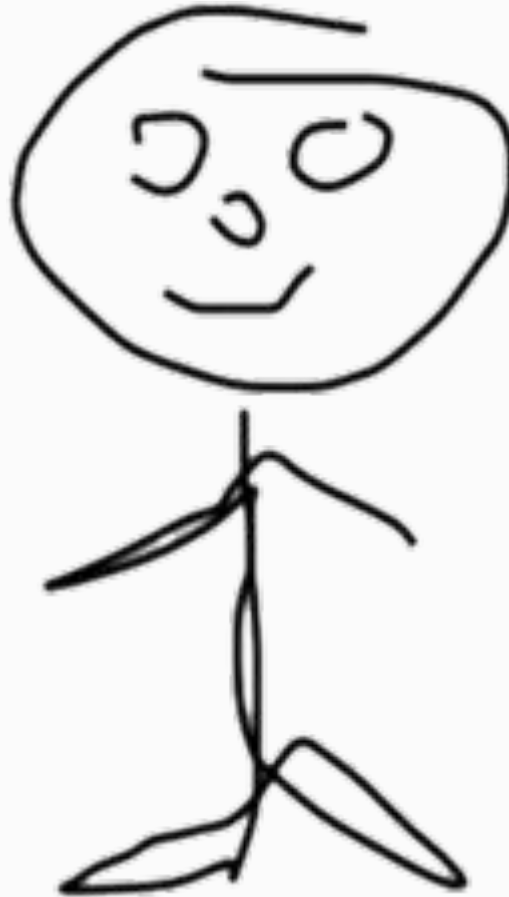
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# Style Transfer

Offline Role Play Game (Style Image)





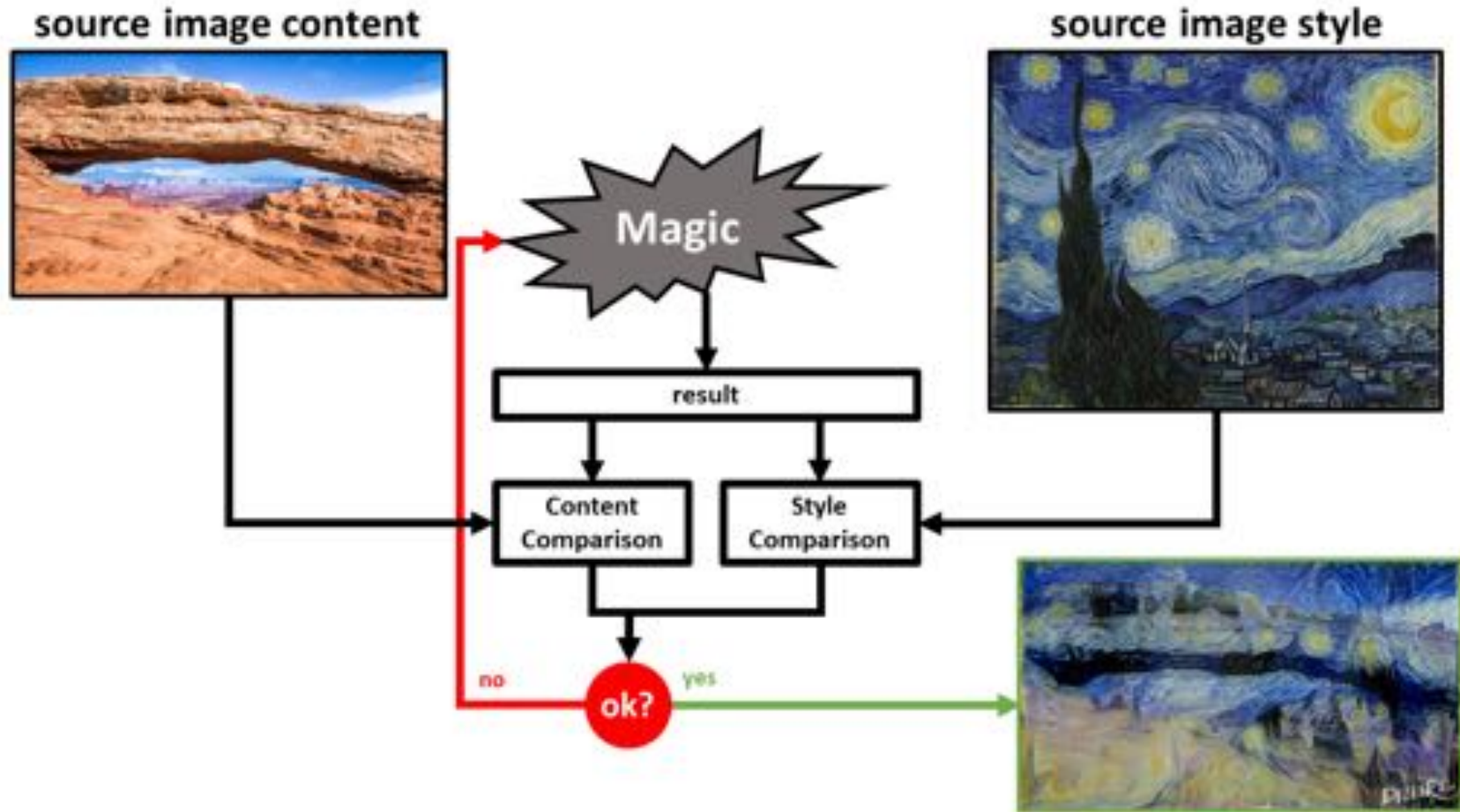
# Technical Implementation





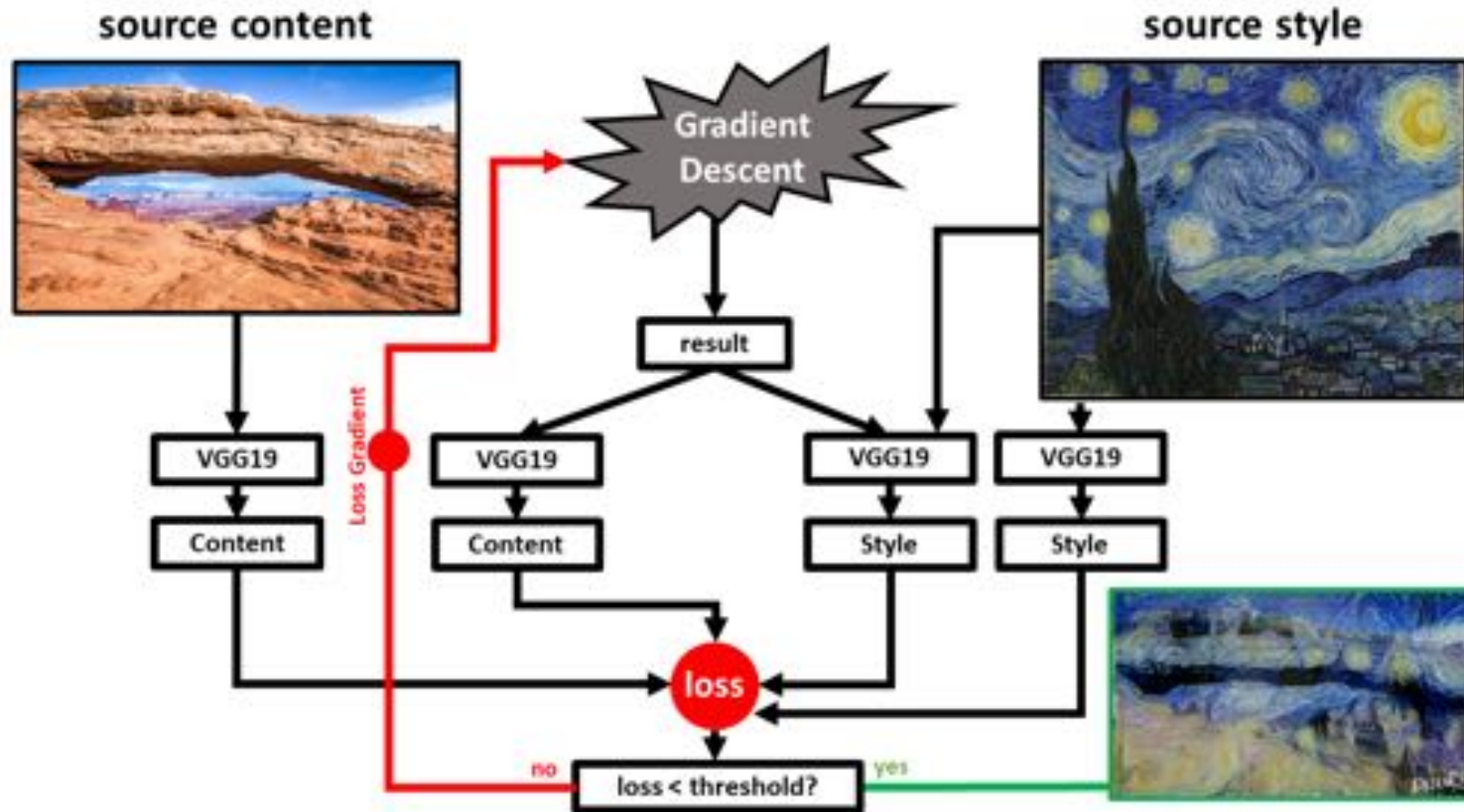
# Technical Implementation

## Style Transfer Workflow



# Technical Implementation

Style Transfer Workflow by Gatys et al. (2015)

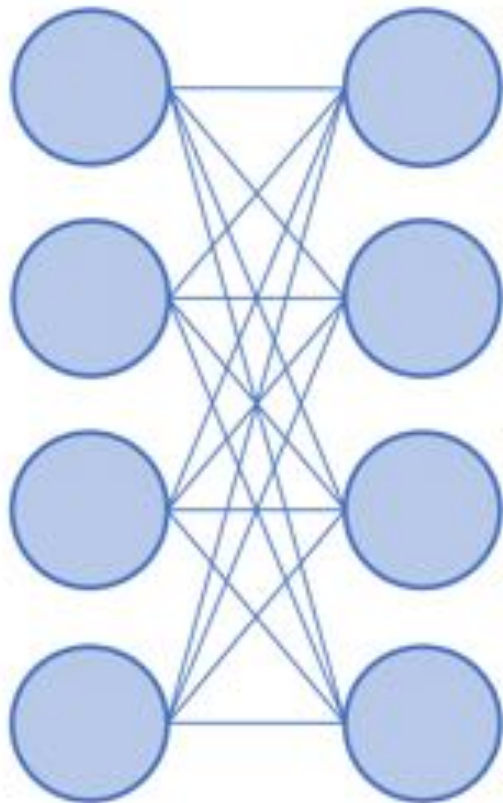




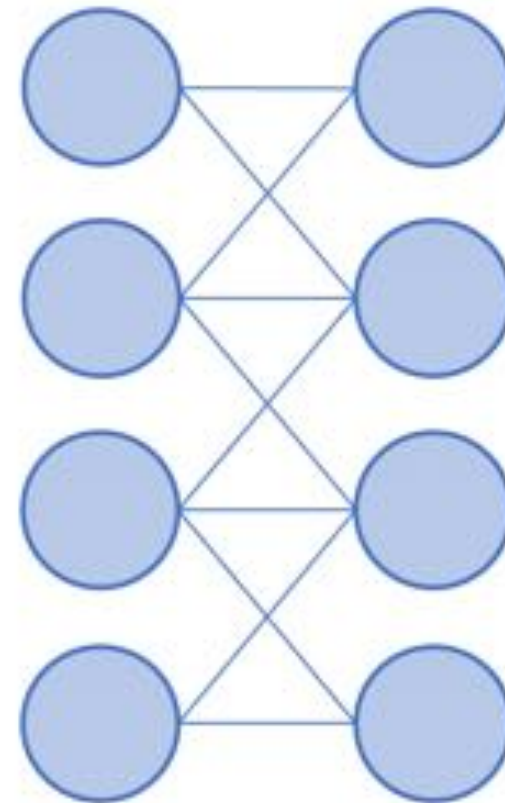
# Technical Implementation

## Fully Connected vs. Convolutional Neural Network Layer

**Fully Connected**

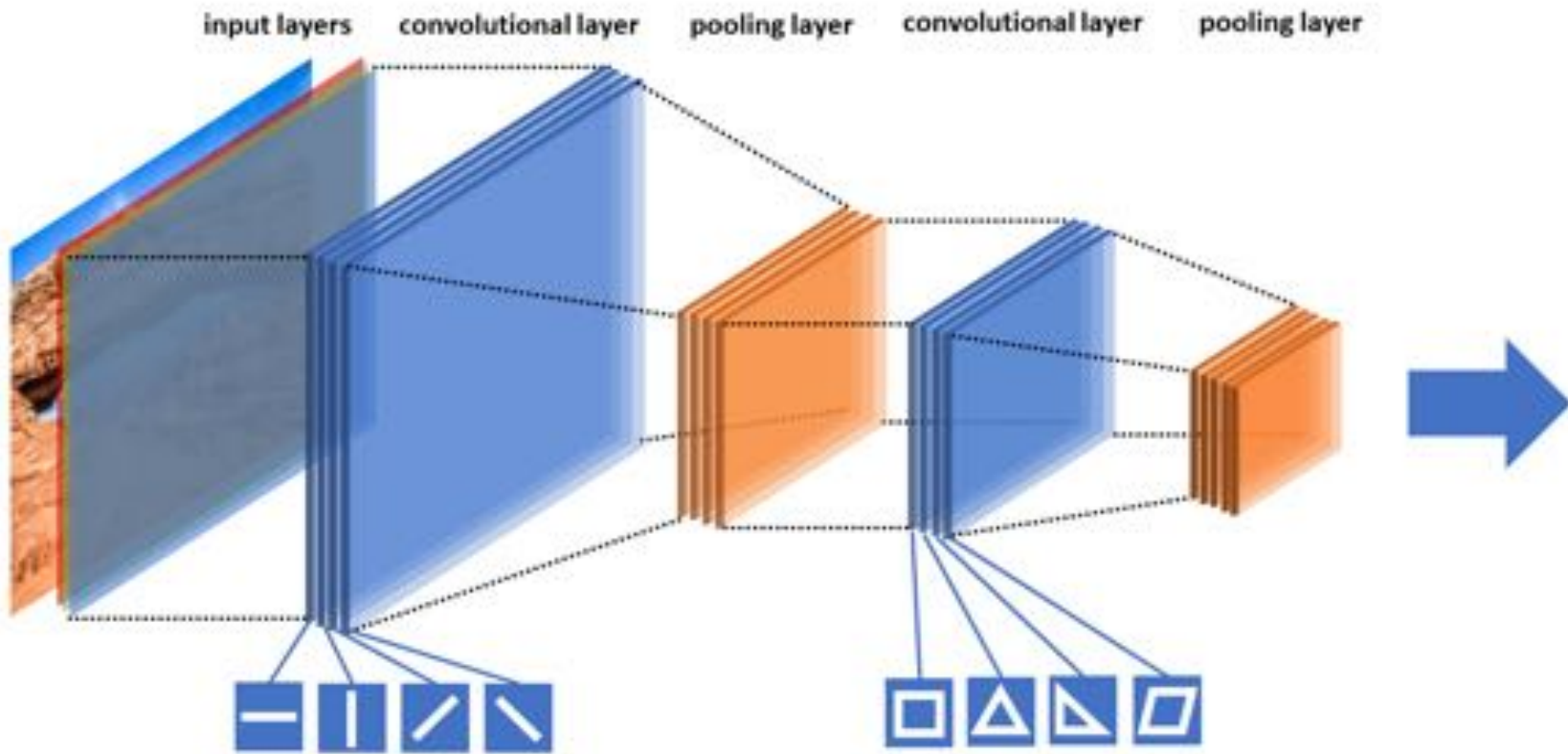


**Convolutional**



# Technical Implementation

## VGG19 Workflow



# Technical Implementation

VGG19 - Live Demo!

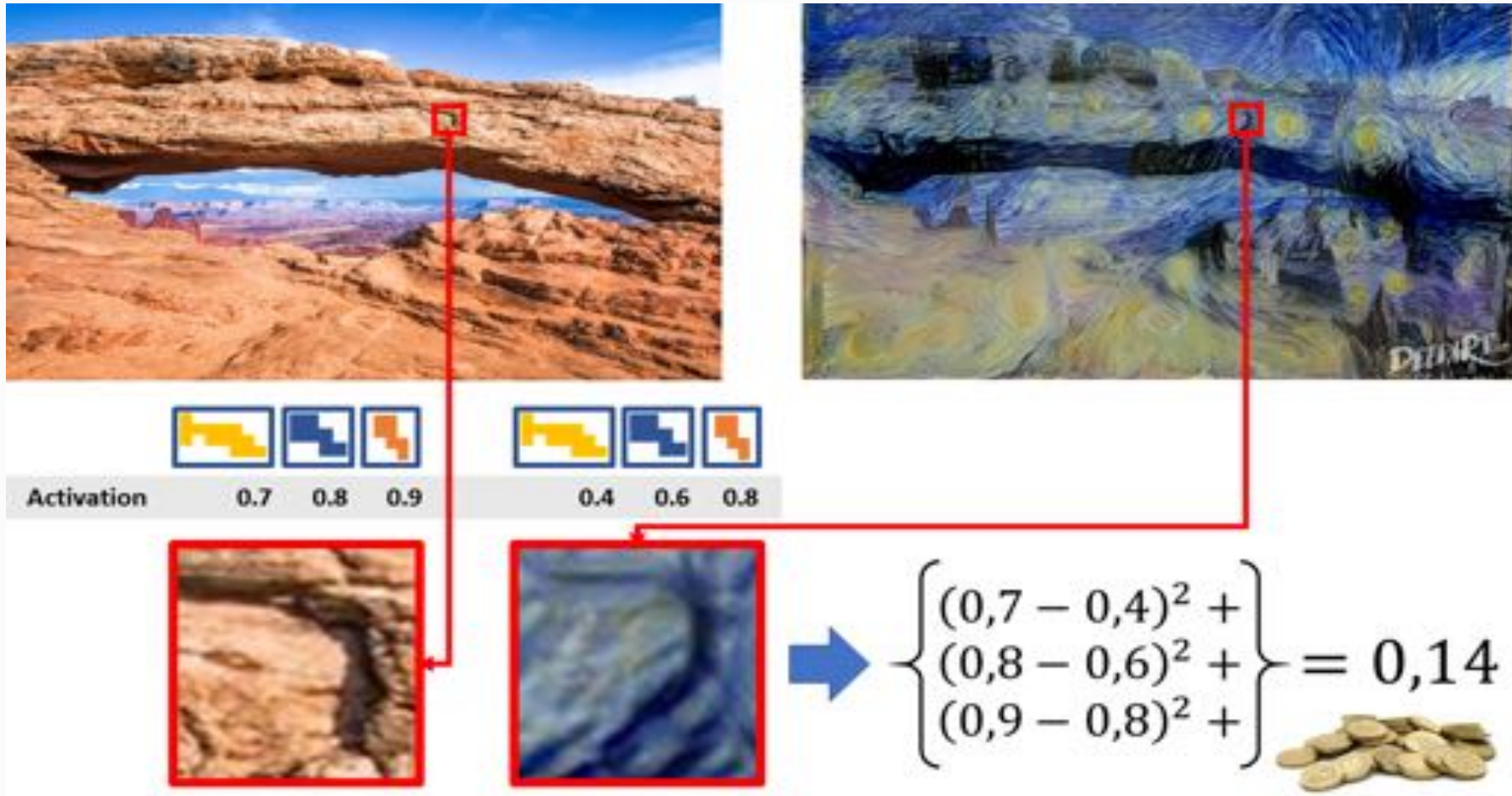


**DEMO**



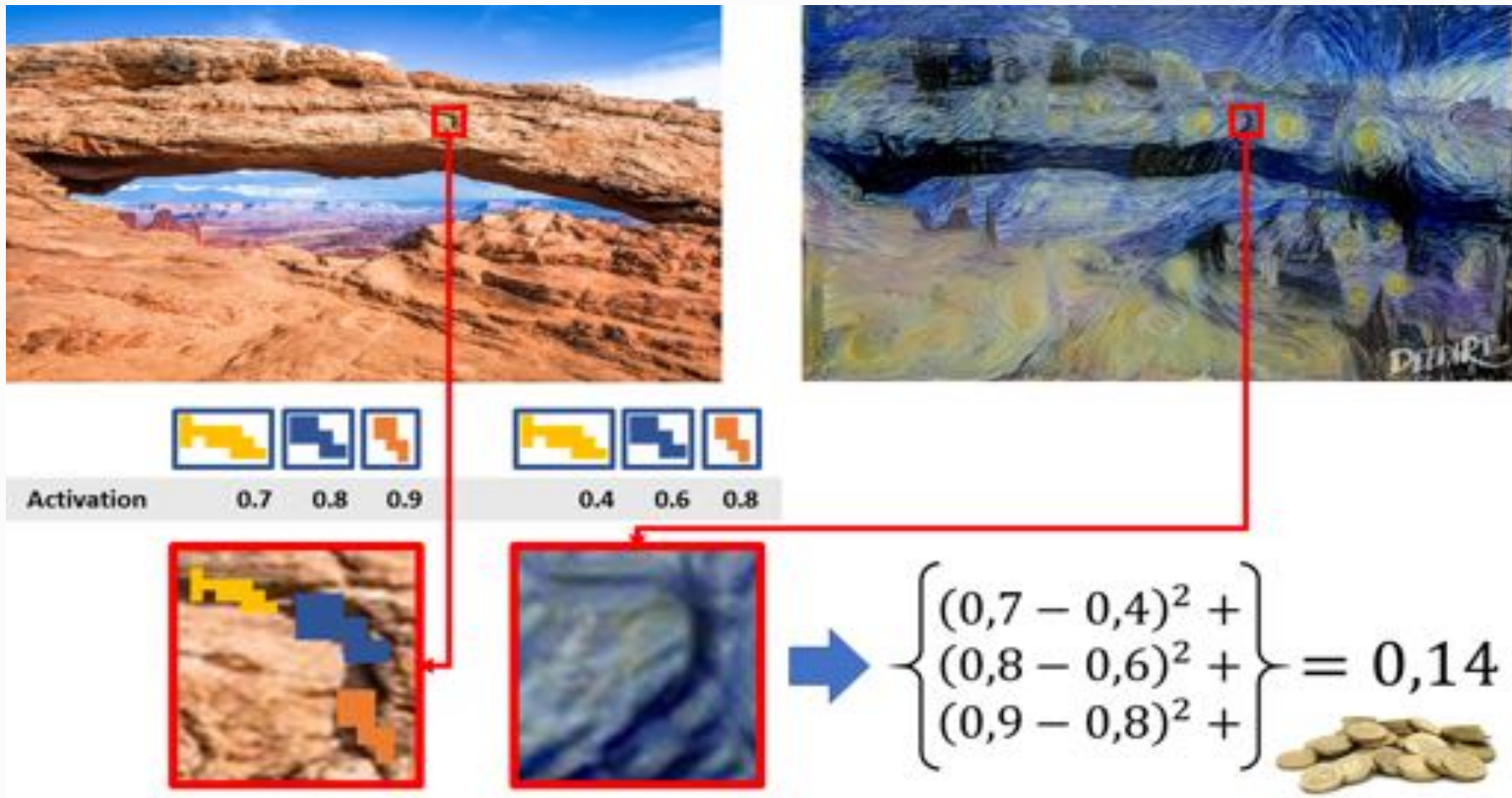
# Technical Implementation

## Calculating Content Loss with VGG19



# Technical Implementation

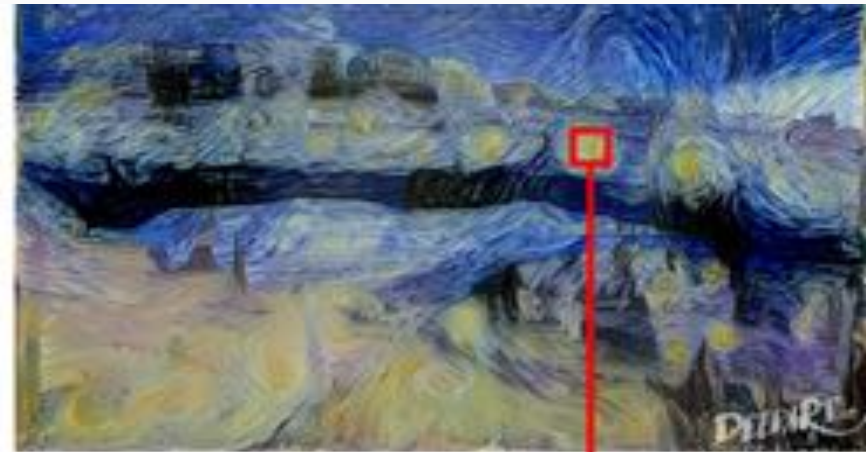
## Calculating Content Loss with VGG19





# Technical Implementation

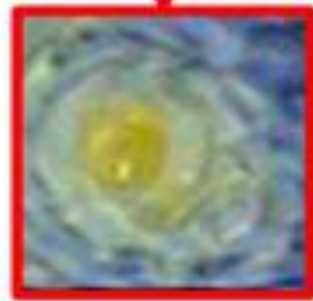
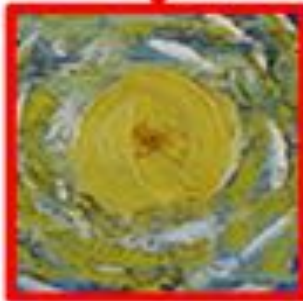
## Calculating Style Loss with VGG19



Activation

1.0

0.4



→  $\{(1.0 - 0.4)^2\} = 0,36$



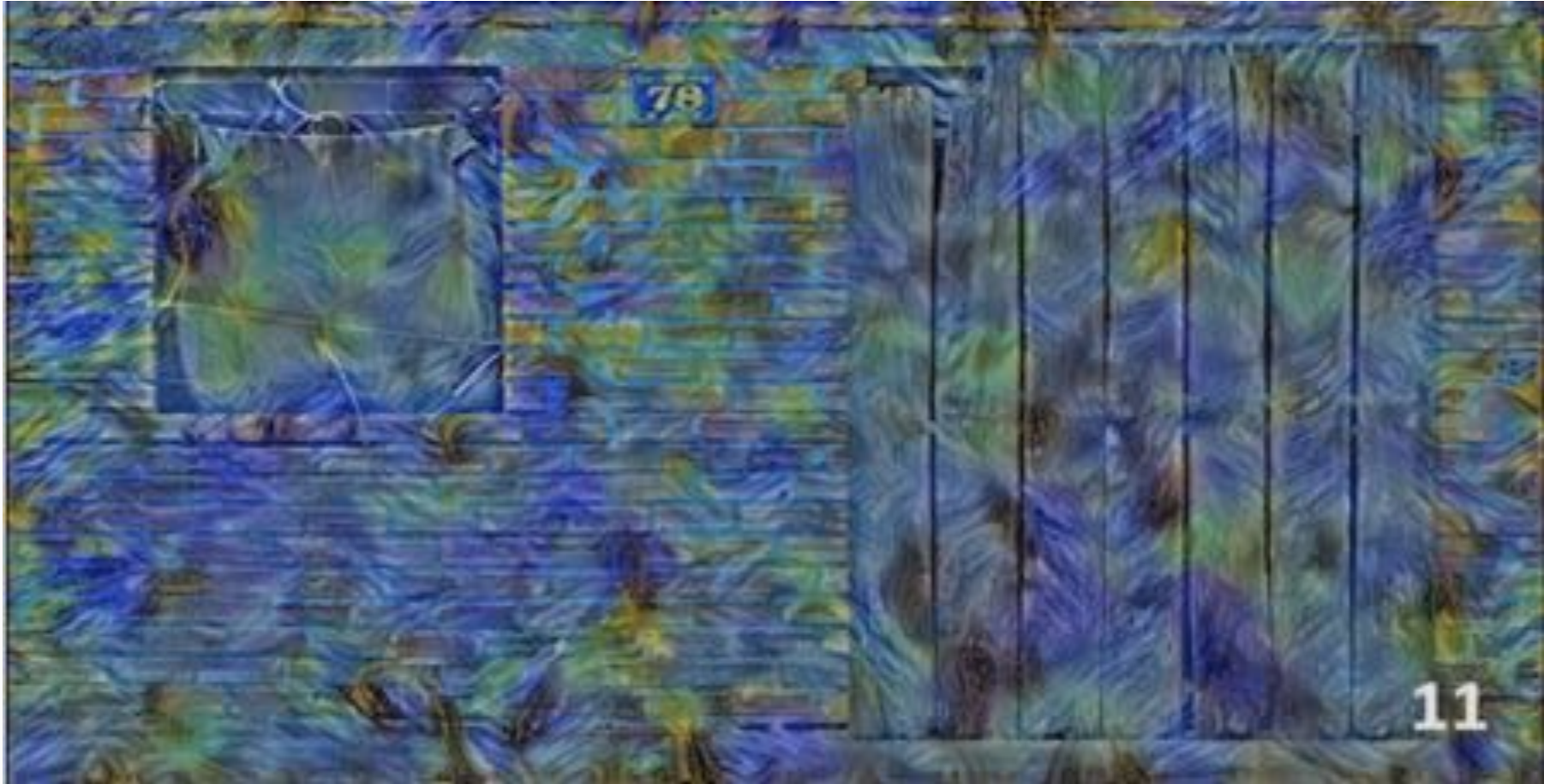
# Technical Implementation

## Style Transfer Inside (VGG19 Layer 2\_2)



# ○ Technical Implementation

## Style Transfer Inside (VGG19 Layer 2\_2)



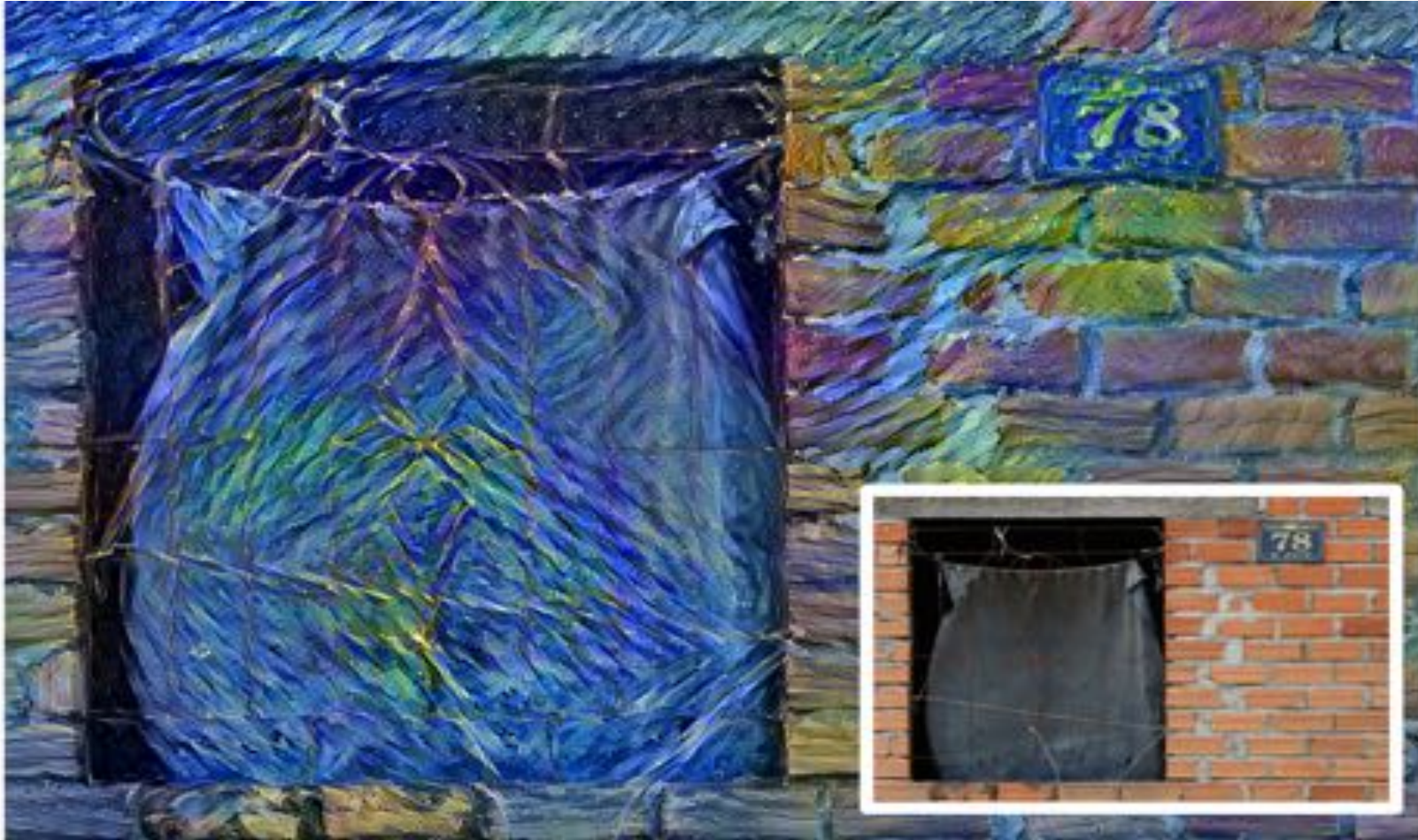
# ○ Technical Implementation

## Style Transfer Inside (VGG19 Layer 4\_2)



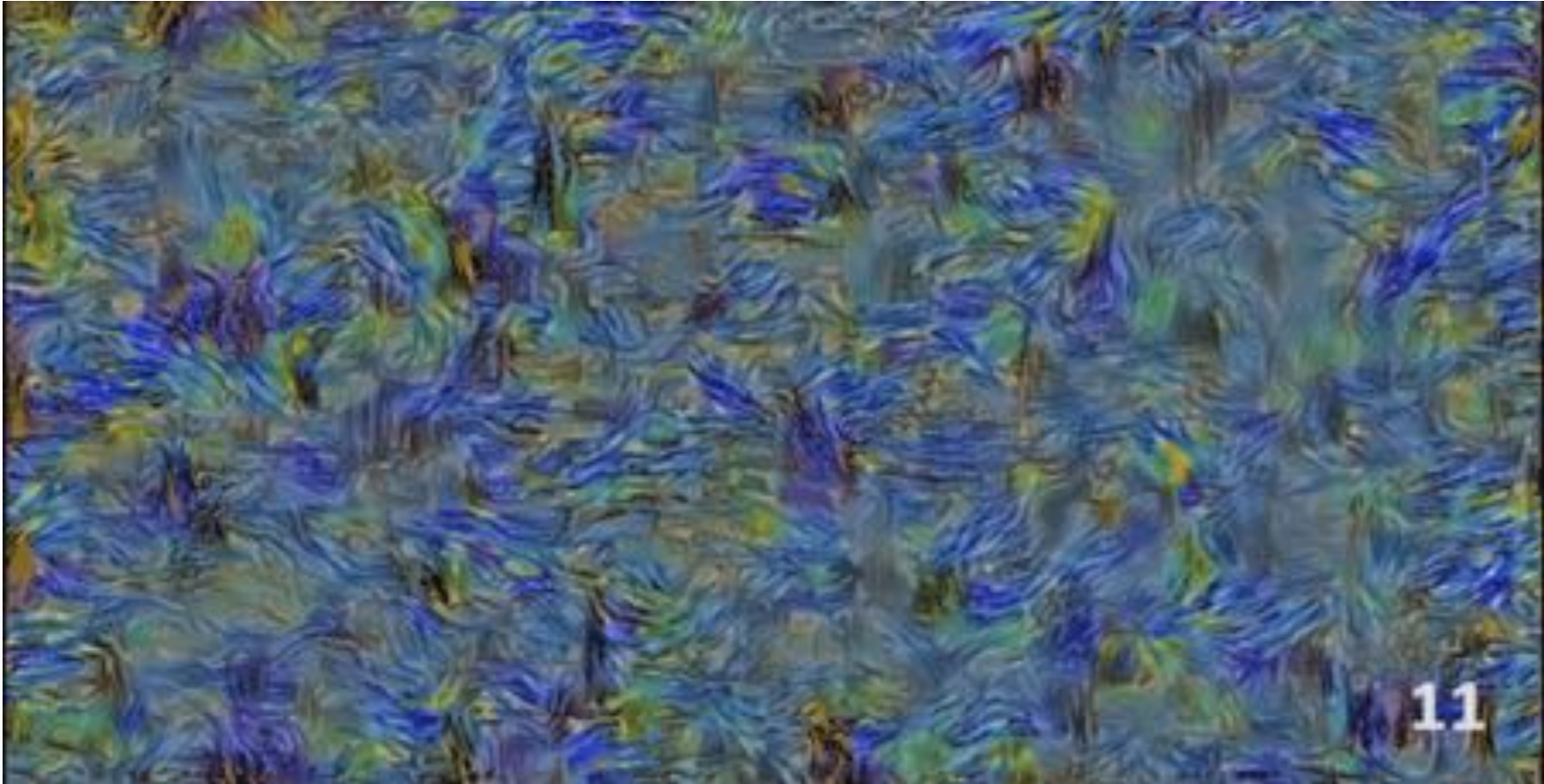
# Technical Implementation

## Style Transfer Inside (VGG19 Layer 4\_2)



# ○ Technical Implementation

## Style Transfer Inside (VGG19 Layer 5\_2)





# Technical Implementation

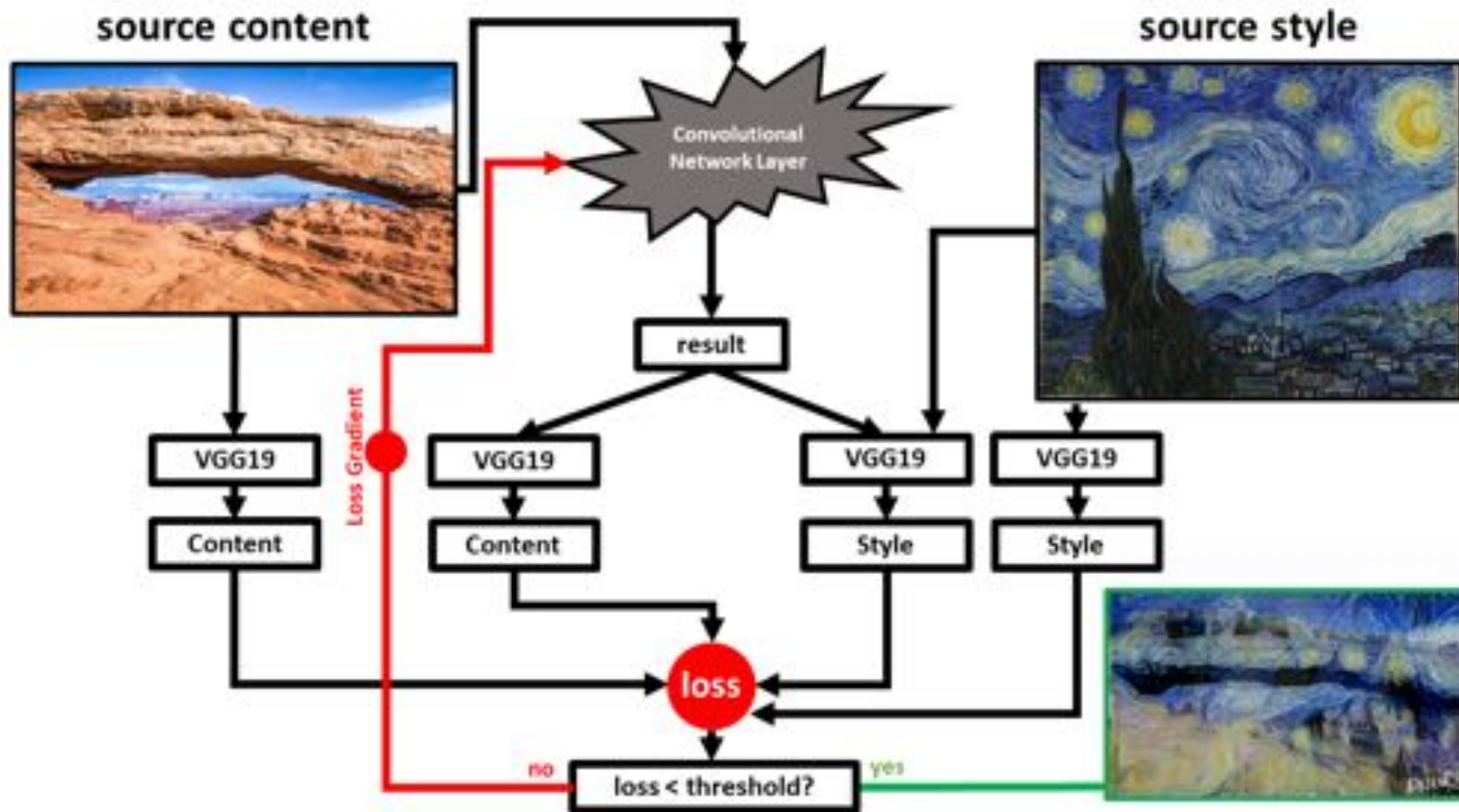
Problems are Time Consumption and Nondeterminism





# Technical Implementation

Fast Style Transfer Workflow by Ulyanov et al. (2016)

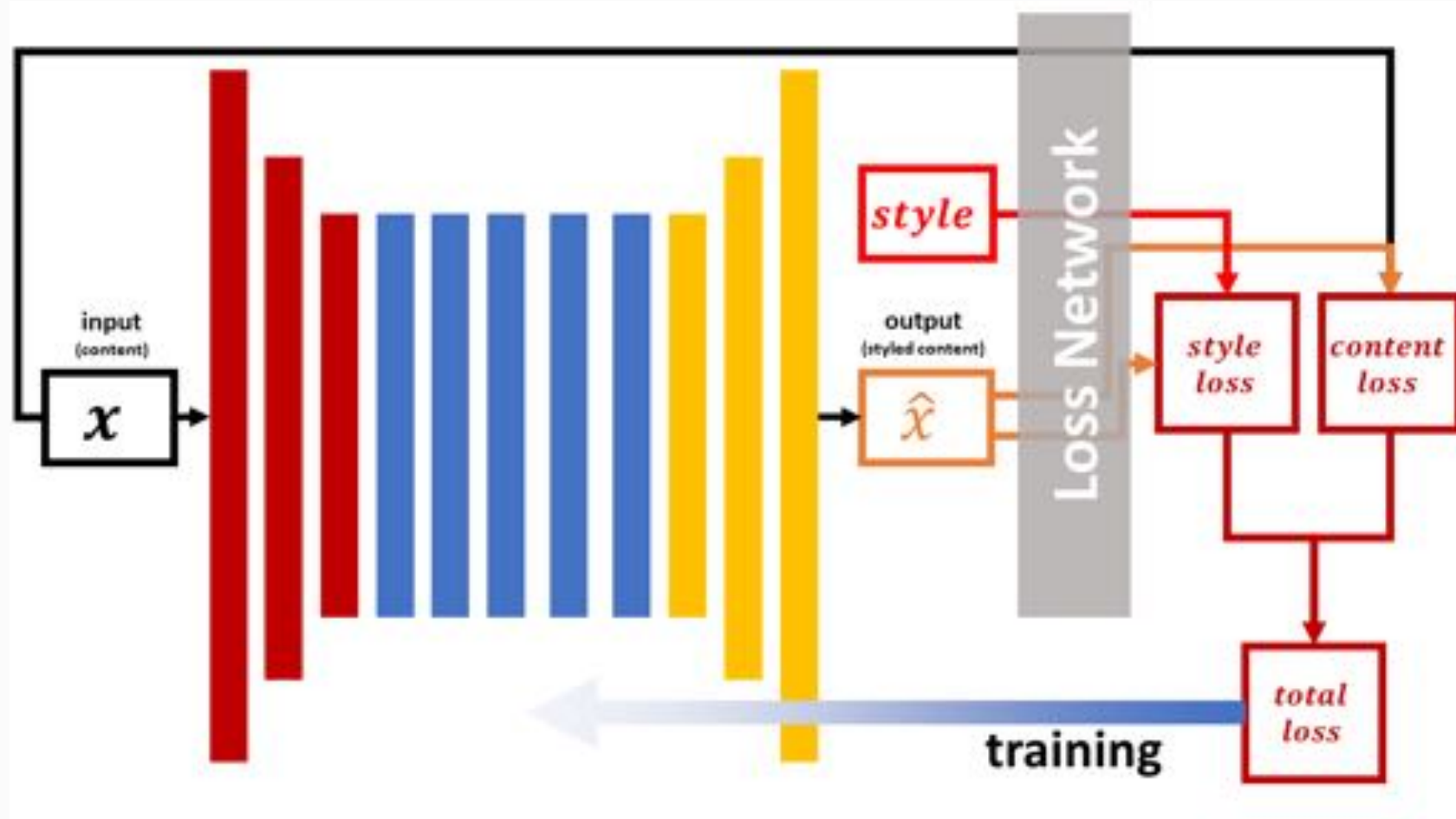






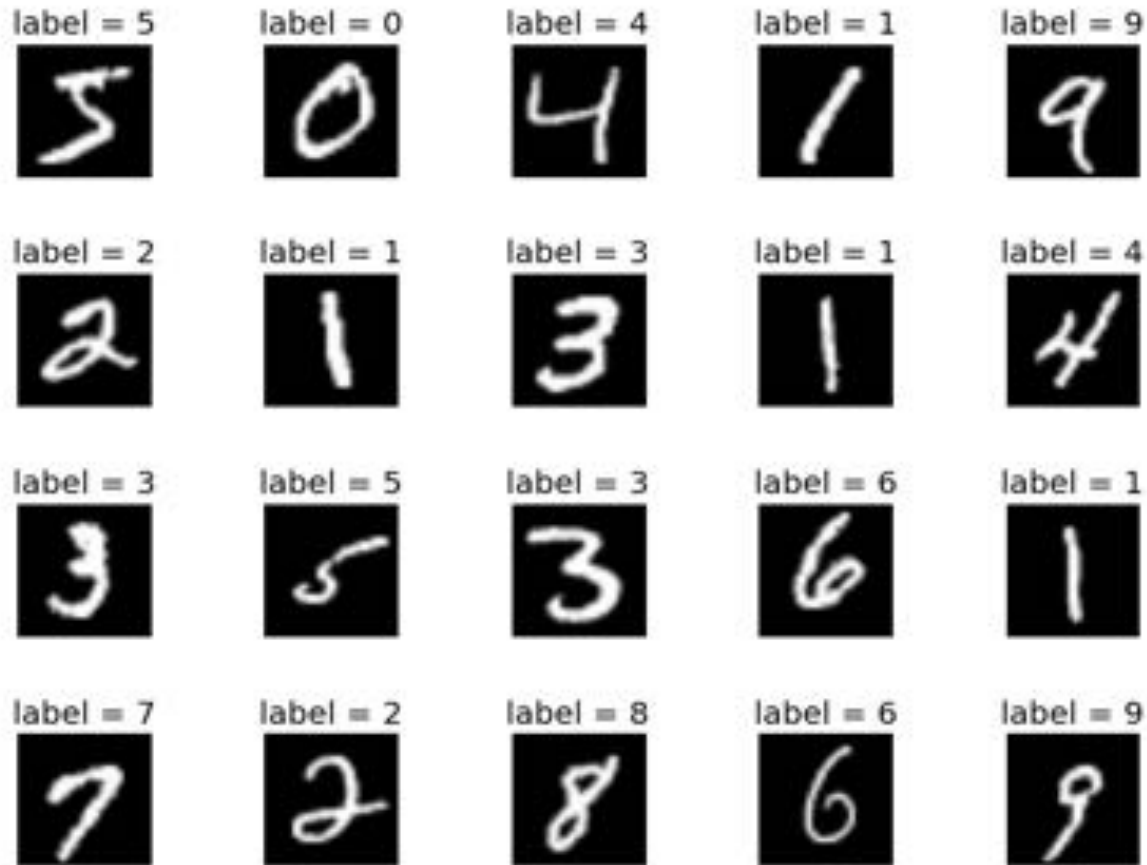
# Code & Technology

## Architecture of the CNN



# Training Datasets

## MNIST



# Training Datasets

## COCO Common Objects in Context



330K images  
(>200K labeled)



80 object-  
91 stuff-  
categories



5 captions  
per image



250,000 people  
with keypoints



# Demonstration Time

## Realtime Style Transfer



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1. <https://medium.com/data-science-group-iitr/artistic-style-transfer-with-convolutional-neural-network-7ce2476039fd>



# Code & Technology

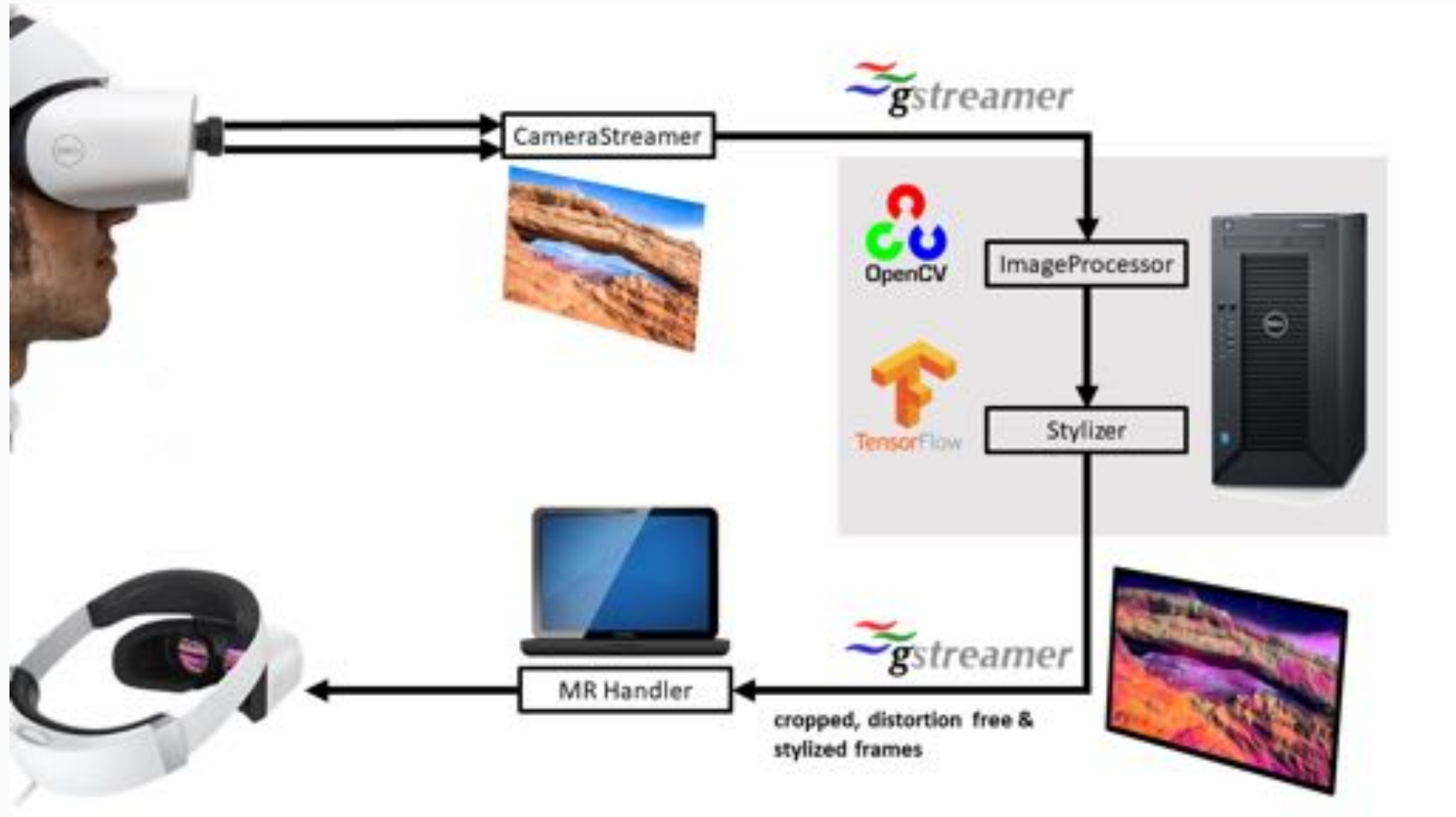
## Dell Visor





# Code & Technology

## Architecture Overview





# Code & Technology

## Training





# Code & Technology

## Limitations









# State of the Art

## Temporal Style Transfer for Videos



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1. <https://www.youtube.com/watch?v=pW6nZXeWIGM>

# State of the Art

## Realtime Human Pose Estimation



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1. <https://www.youtube.com/watch?v=pW6nZXeWIGM>

# Experiment Time

Let's do something crazy!





# Experiment Time

Let's do something crazy!



# Experiment Time

Let's do something crazy!



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Let's do something crazy!






# Experiment Time

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