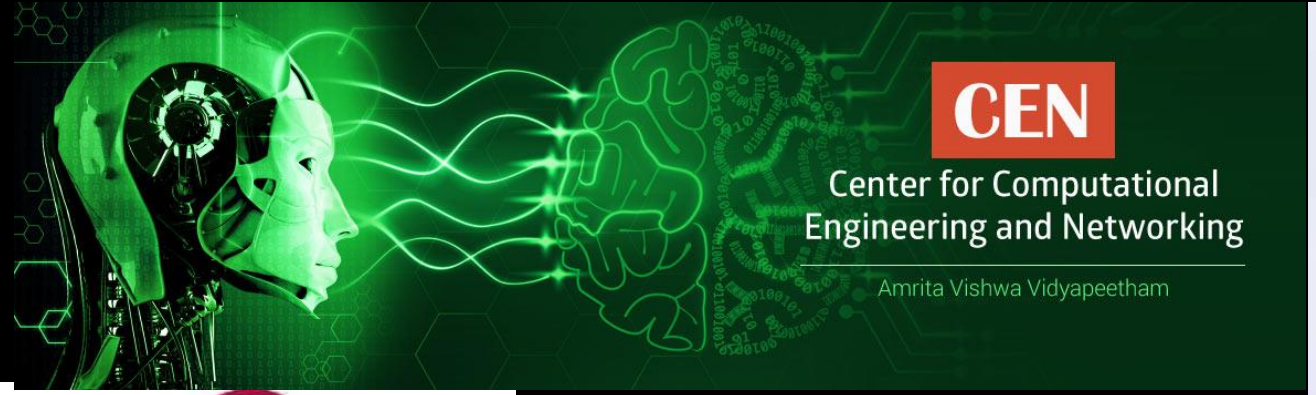


Deep Learning for Image Segmentation & GAN

By Sajith variyar V V, Amrita Vishwa Viyapeetham , CEN Dept, Coimbatore

Are we all know the right AI /ML ?

"A lack of understanding of underlying AI/ML algorithms both makes it easy for companies to inflate claims and also makes it difficult for potential investors, partners, and customers to identify true breakthrough innovation. "

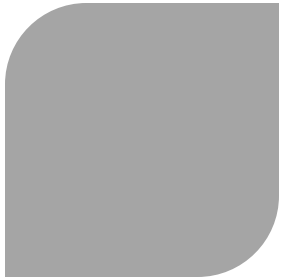
SPECTRUM OF ALGORITHMS UNDERPINNING AI (EXCERPT)

ROCK HEALTH

	EXPERT SYSTEMS	TRADITIONAL MACHINE LEARNING	FRONTIER MACHINE LEARNING
SUMMARY	Human-programmed, static program to perform a single, deterministic task	Algorithms mathematically proven to make an optimum or best prediction based on data they are trained with	Algorithms with the same characteristics as traditional machine learning (learn from and improve predictions through data) but with greater autonomy and less explainability
PERIOD OF MAJOR BREAKTHROUGHS	1980s-1990s	2000s	2010s-present
AUTONOMY	Low, program is entirely dependent on human-provided information	Medium, generally humans guide the model to take into account certain features and to remove "noisy" outlier data	High, generally the model decides on feature selection and weighting and has to account for outlier data independently
EXPLAINABILITY	High	Medium	Low, "black box"

To be an AI Engineer !!!

MATHEMATICAL EXPERTISE



COMPUTATIONAL SKILLS

PROGRAMMING SKILLS

What made AI and ML to grow faster

Neural Networks Concepts were developed many years back

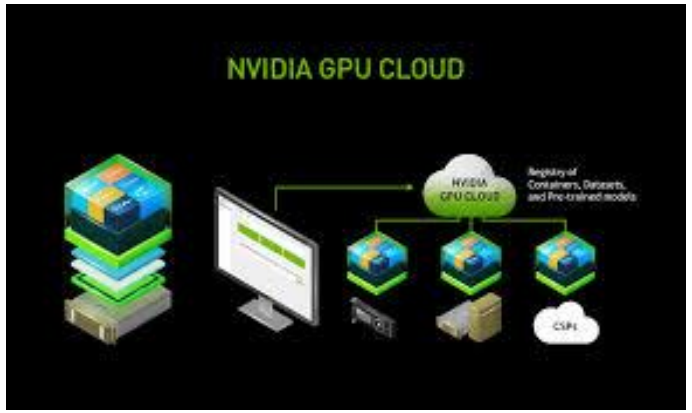
The development in computational hardwares and frameworks give the moonlight for faster growth.

Huge storage and data sources available.

AI and ML Platforms

AI platforms and frameworks as a Service

- Google Cloud Platforms
- Amazon Webservices
- Nvidia Computational Hardwares & Online Platforms



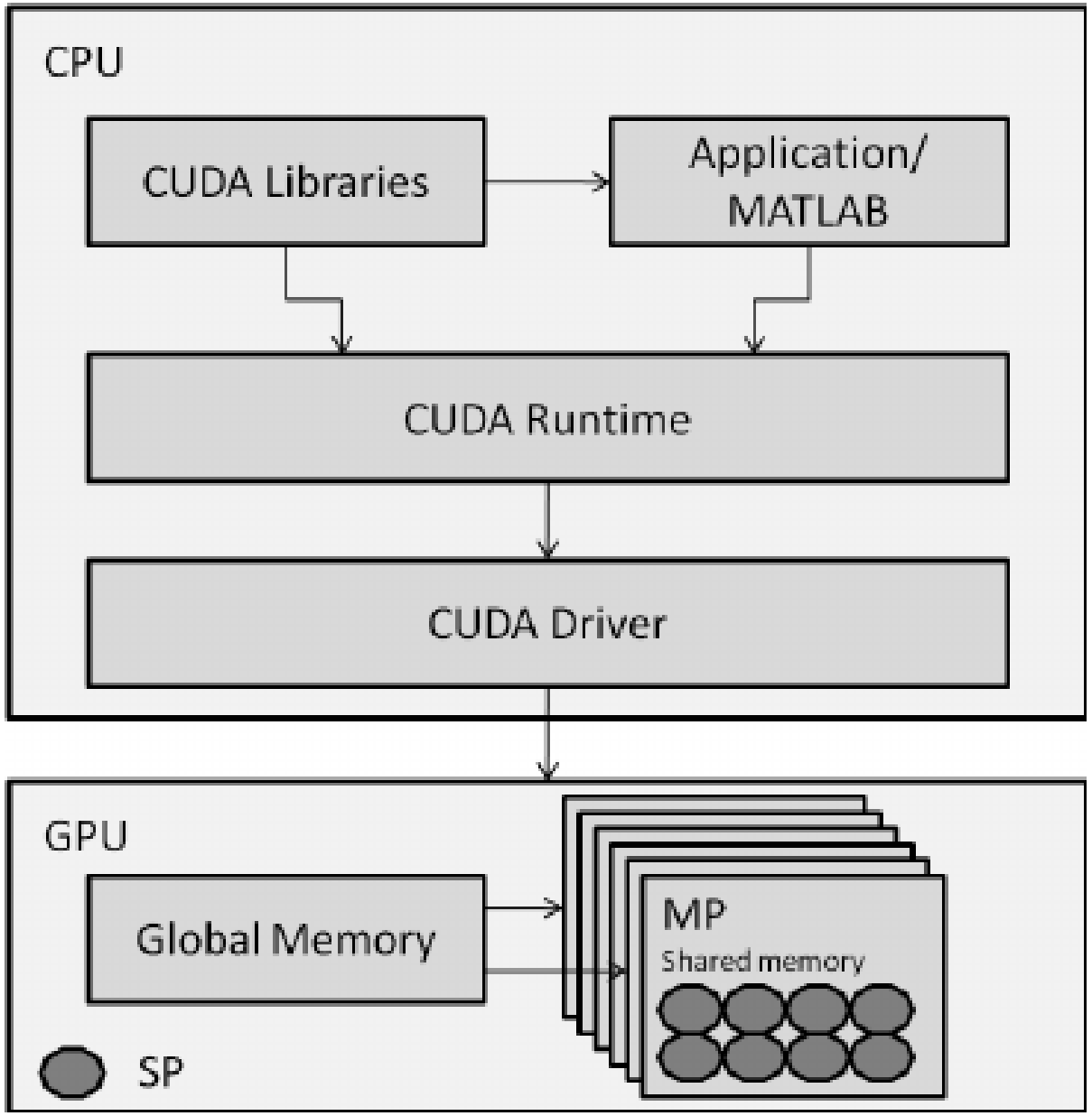
Upgrade your Computational Systems

- Most of the people started using GPU' instead of CPU's
- The computations are faster
- AI models can be trained in fewer days
- Next trend is going with TPU's , which makes the computation faster than GPU
- Near future we will have Quantom Computing platforms for AI

" Training machine learning models with thousands or more training examples on a CPU (central processing unit) can take days if not weeks, all the while, draining away at your patience! "

Sample Nvidia GPU Configuration

	K20X	K40
Peak Single Precision Peak SGEMM	3.93 TF 2.95 TF	4.29 TF 3.22 TF
Peak Double Precision Peak DGEMM	1.31 TF 1.22 TF	1.43 TF 1.33 TF
Memory size	6 GB	12 GB
Memory BW (ECC off)	250 GB/s	288 GB/s
Memory Clock	2.6 GHz	3.0 GHz
PCIe Gen	Gen 2	Gen 3
# of Cores	2688	2880
Core Clock	732 MHz	Base: 745 MHz Boost Clocks: 810 & 875 Mhz
Total Board Power	235W	235W
Form Factor	PCIe Passive	PCIe Passive, Active


CPU
CUDA Libraries
Application/
MATLAB
CUDA Runtime
CUDA Driver
GPU
Global Memory
MP
Shared memory
SP

Machine Learning / Deep learning Application

Python Compiler – 2.7, 3.3, 3.8

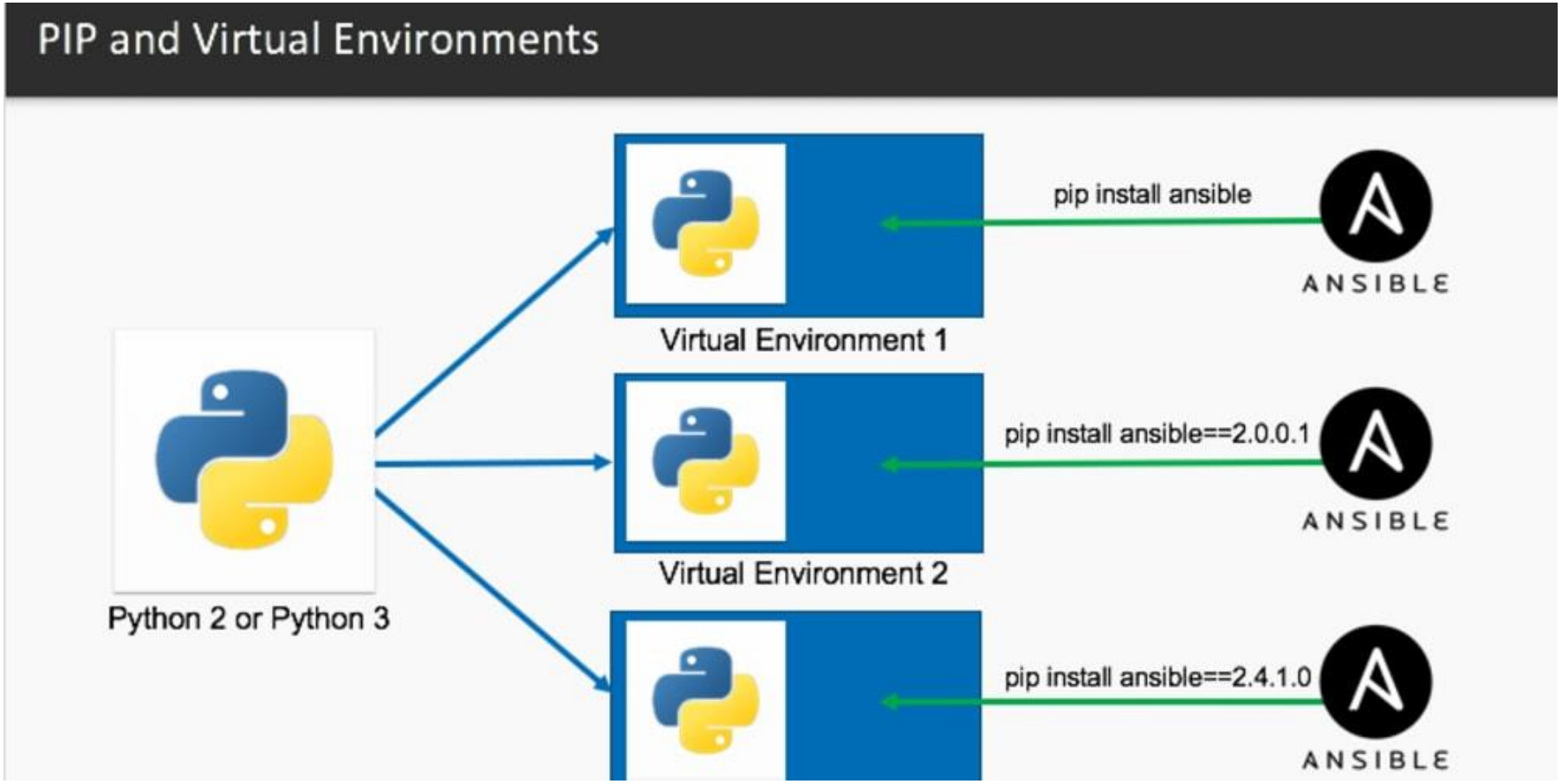
Virtual Env

CUDA Libraries / GPU Drivers

Operating System – Windows / Linux / Mac

CPU and GPU

Python virtual Environment



python™
virtualenv

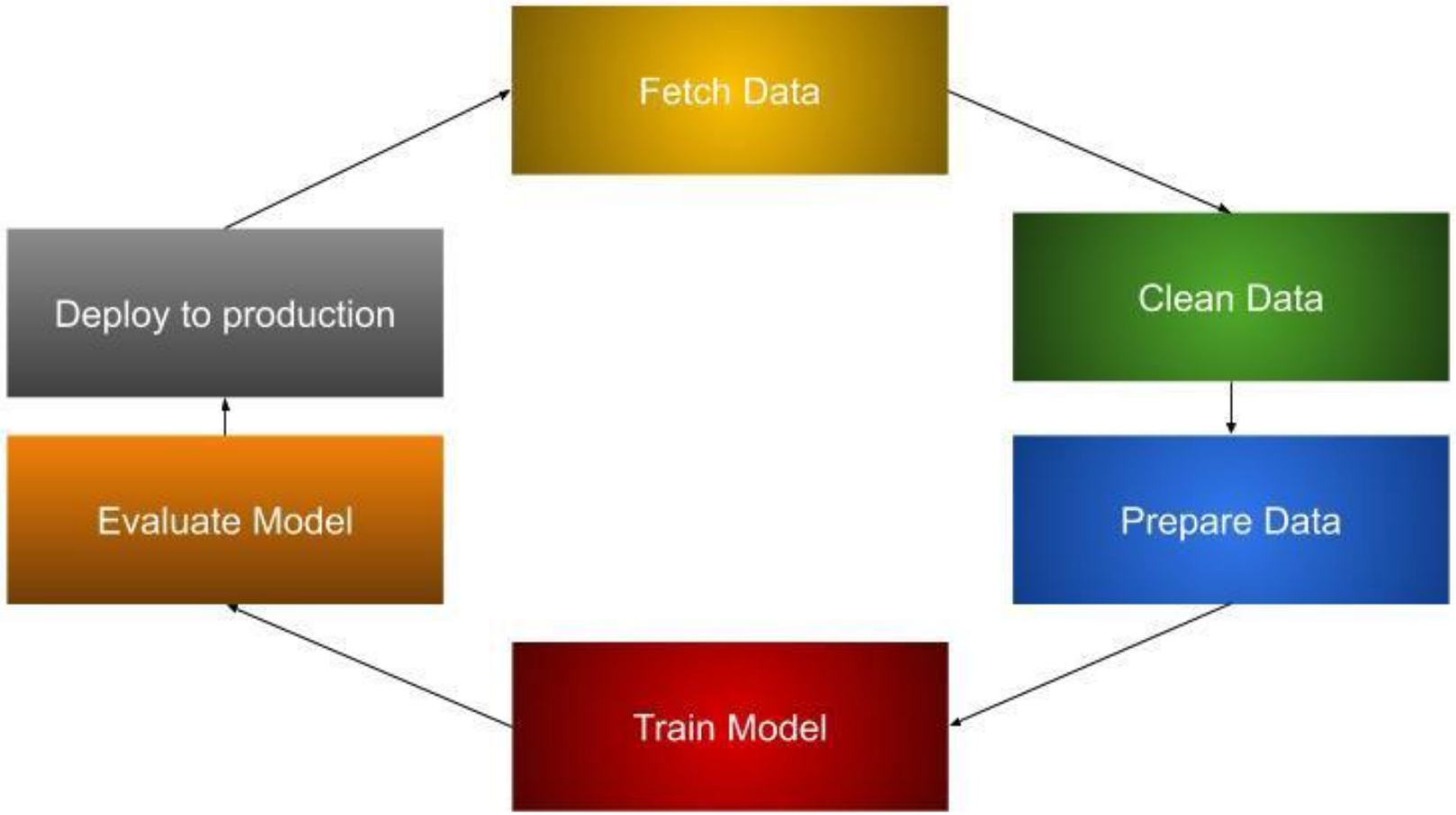
VENV

PyEnv

python3 -m venv /path/to/new/virtual/environment

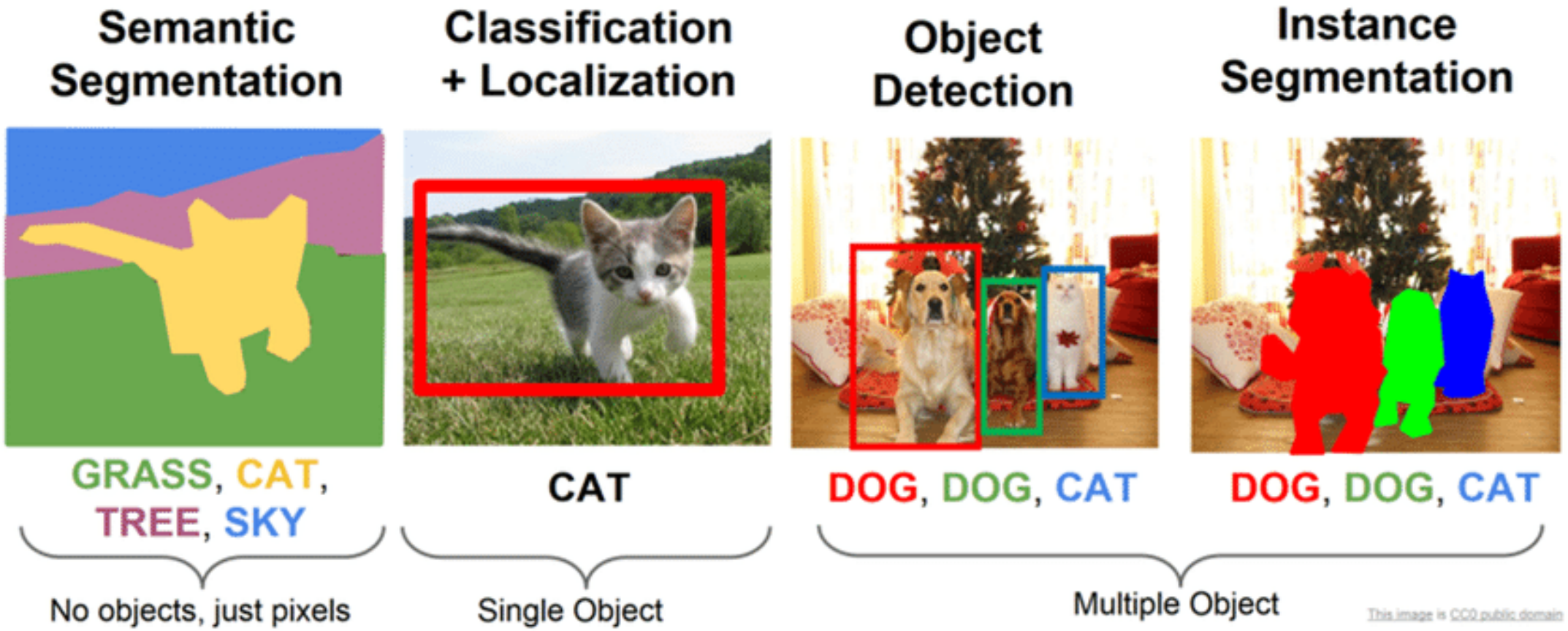
Python for Deep Learning

A Basic Deep Learning Application Cycle



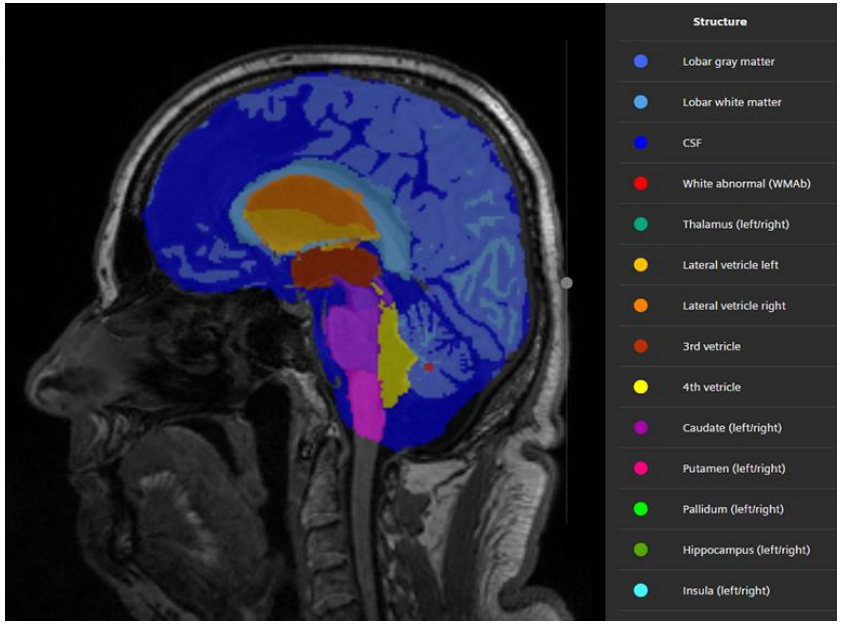
Data is the Gold Mine

Major Computer vision tasks

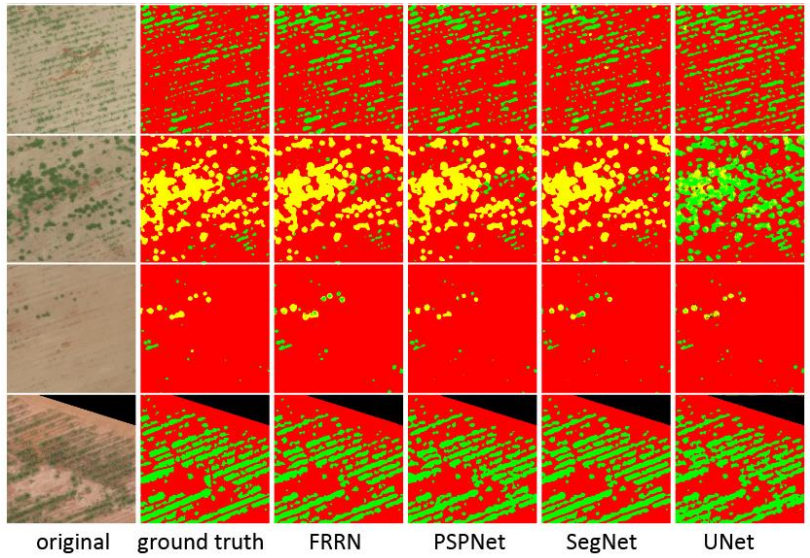


Deep learning in Image segmentation

Vehicle Automation



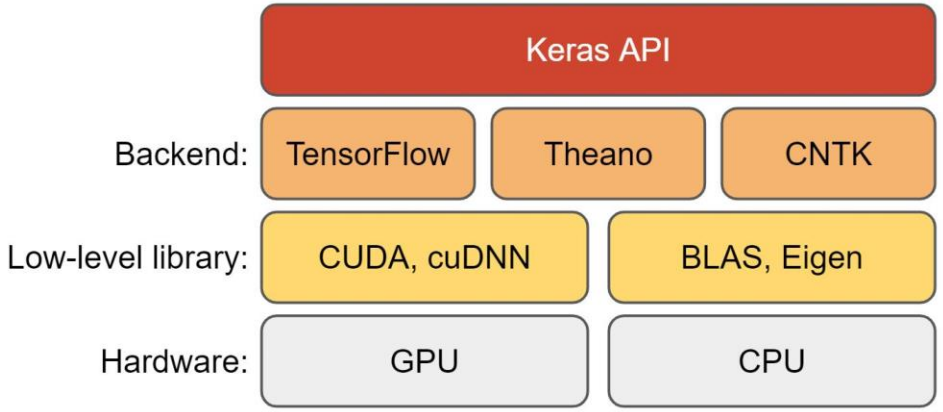
Healthcare

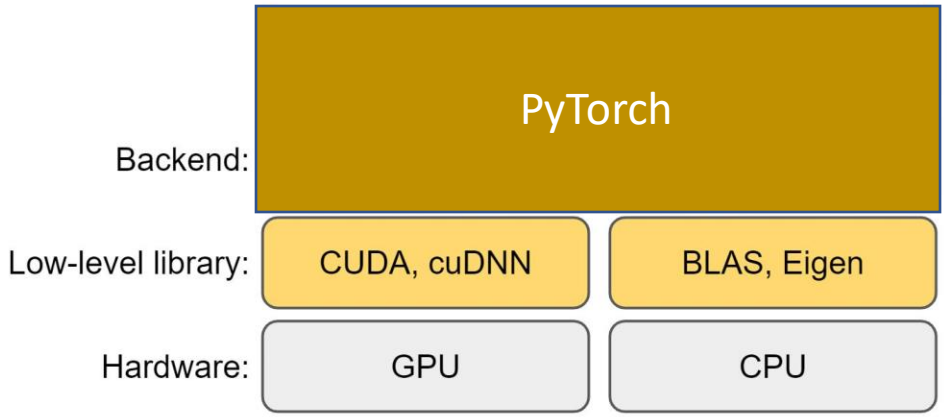


Precision Agriculture

Model Building In Python

NN Front End and Back End





A Major Step before DL based Image Analysis

- Data Preprocessing
- Data Annotations

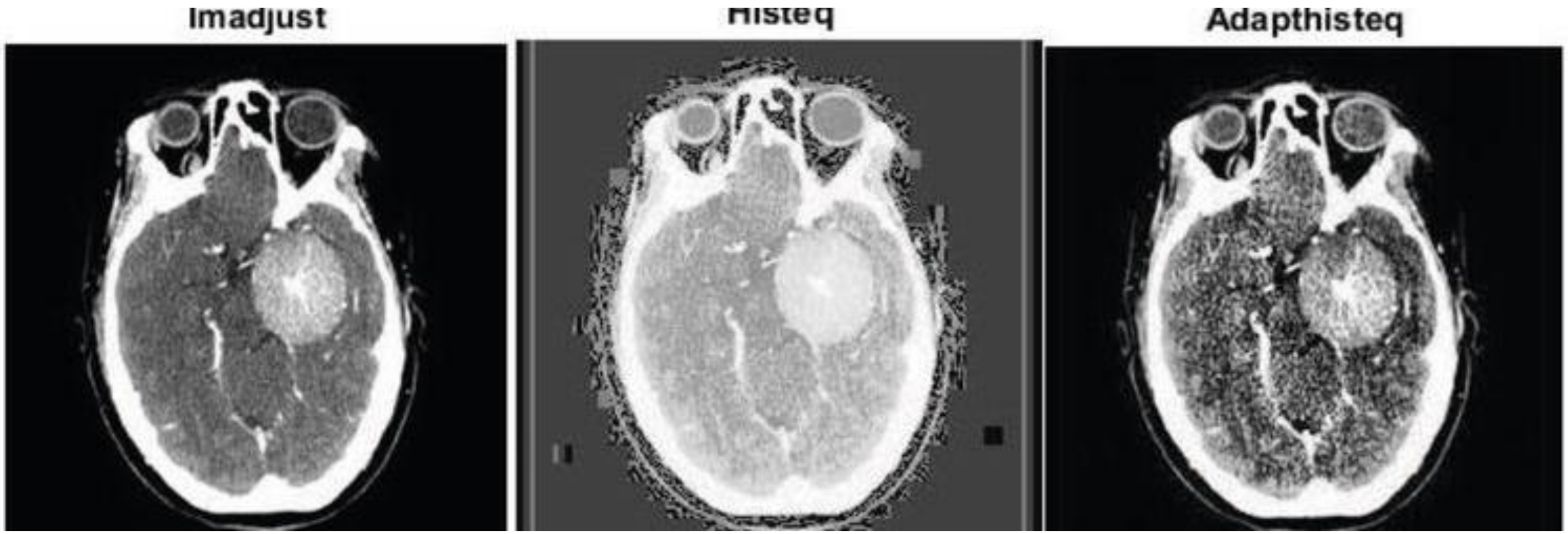
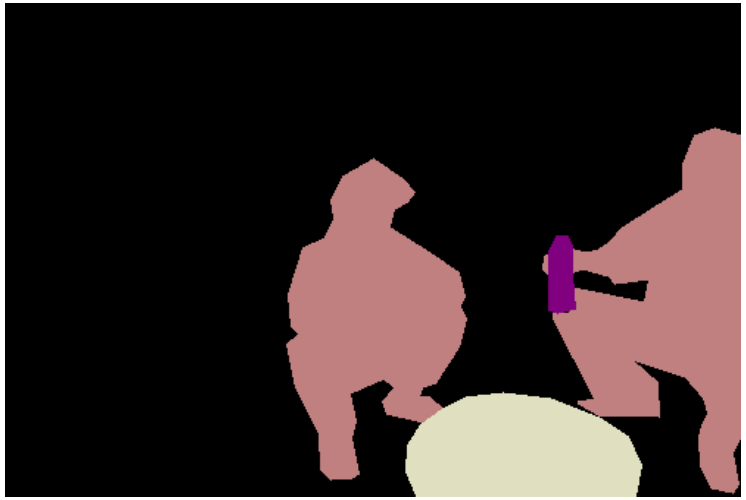


Image Preprocessing

- Contrast and Image quality are the major problems in medical imagery. Image Enhancement makes the image clear for human perception or machine analysis.

Python Image processing libraries

Image Annotation – Example 1



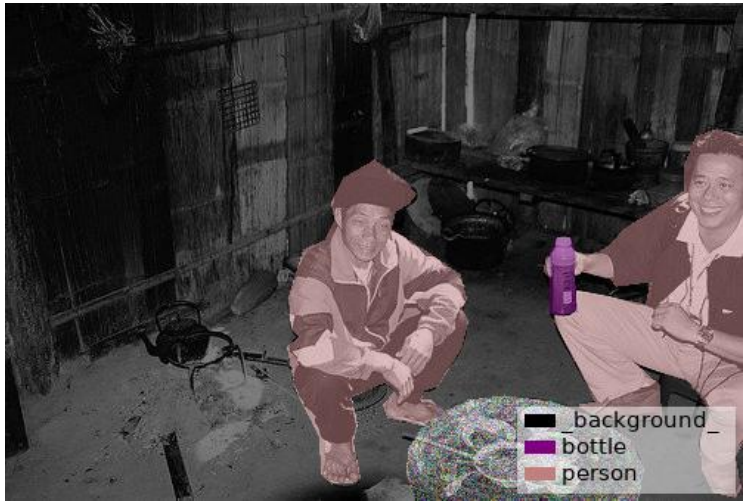
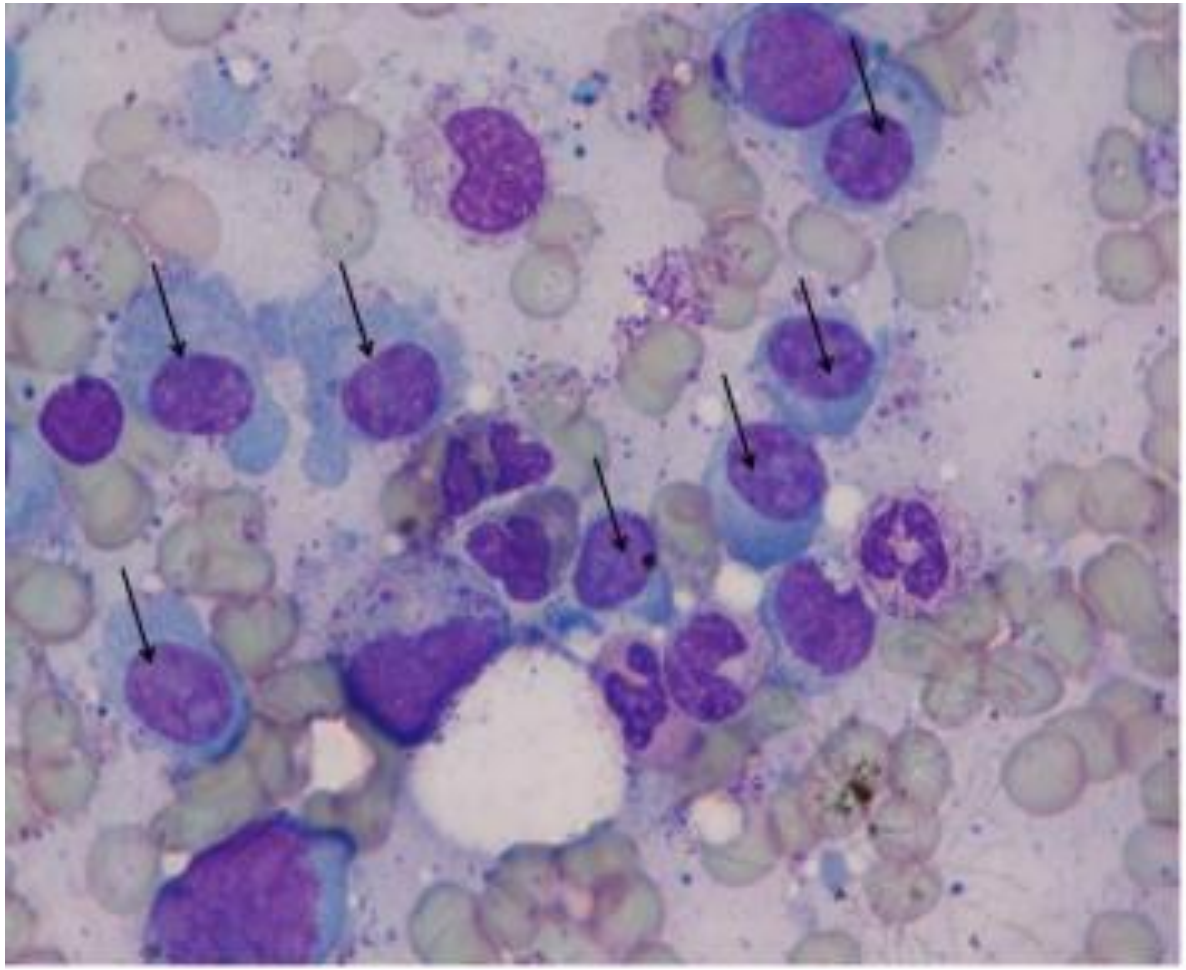


Image Annotation – Example 2

Multiple myeloma cancer is caused by the abnormal growth of plasma cells in the bone marrow.



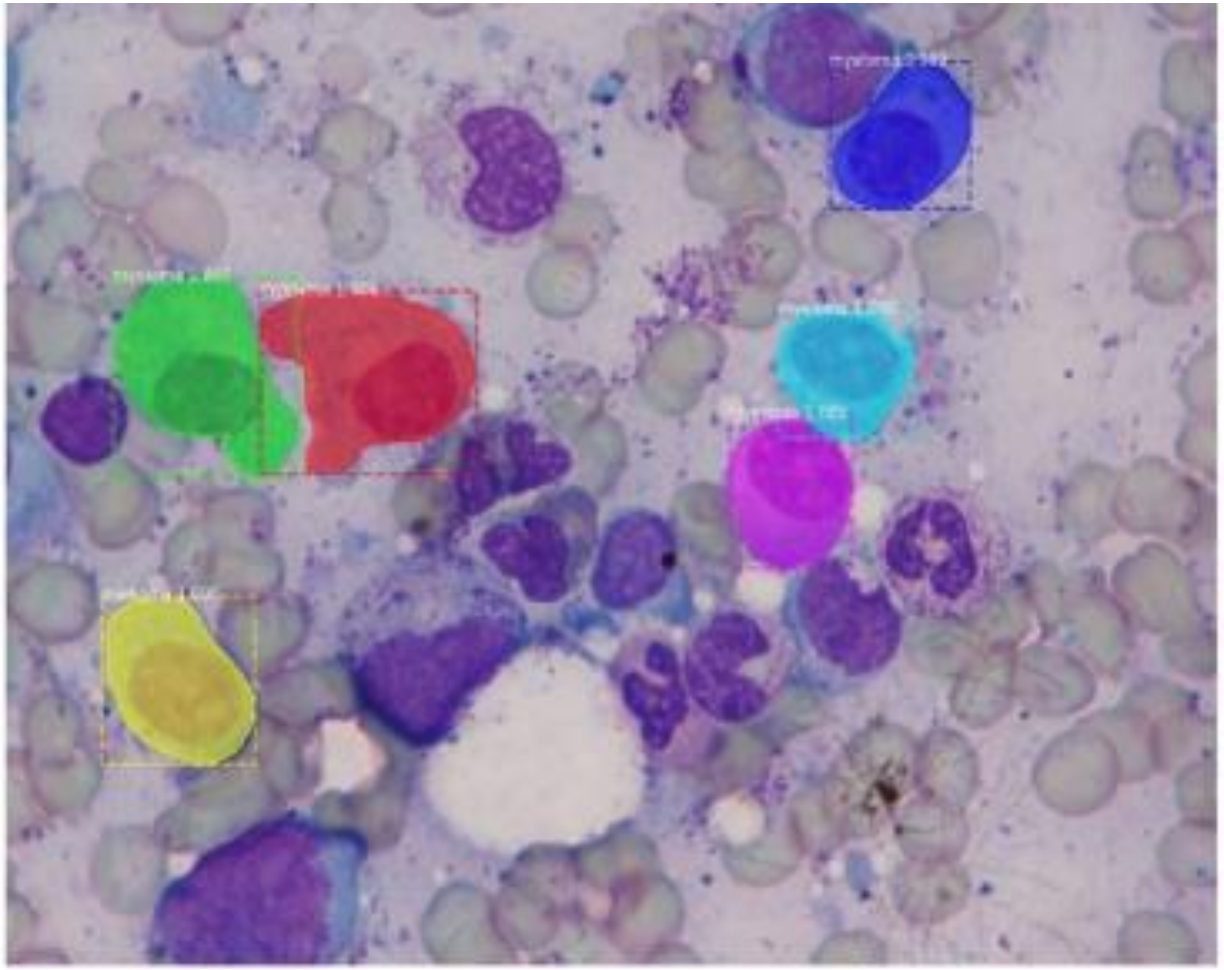


Image Annotation tools

- MATLAB Has Annotation tools as Plugins
- VGG Annotation tool – Supports Bounding Box / Pixel based segmentation also
- TrainingData.io: TrainingData.io is a medical image annotation tool for data labeling. It supports DICOM image format for radiology AI.
- **LabelME** – Allows pixel wise and box annotations
- **Lionbridge AI:** Lionbridge AI has deep experience in all aspects of the medical devices vertical. We have 500,000 qualified contributors who can provide image annotation services quickly, with high precision. In addition, Lionbridge's team can help you manage your project timeline, budget, and quality control.
- **ImageJ:** ImageJ is a Java-based image processing program developed at the National Institutes of Health and the Laboratory for Optical and Computational Instrumentation.
- OsiriX Viewer: OsiriX is an image processing application for Mac dedicated to DICOM images produced by equipment. OsiriX is complementary to existing viewers, in particular to nuclear medicine viewers. It can also read many other file formats: TIFF (8,16, 32 bits), JPEG, PDF, AVI, MPEG and QuickTime.
- ITK-SNAP: ITK-SNAP is a free-software and cross-platform tool that provides semi-automatic segmentation using active contour methods, as well as manual delineation and image navigation.

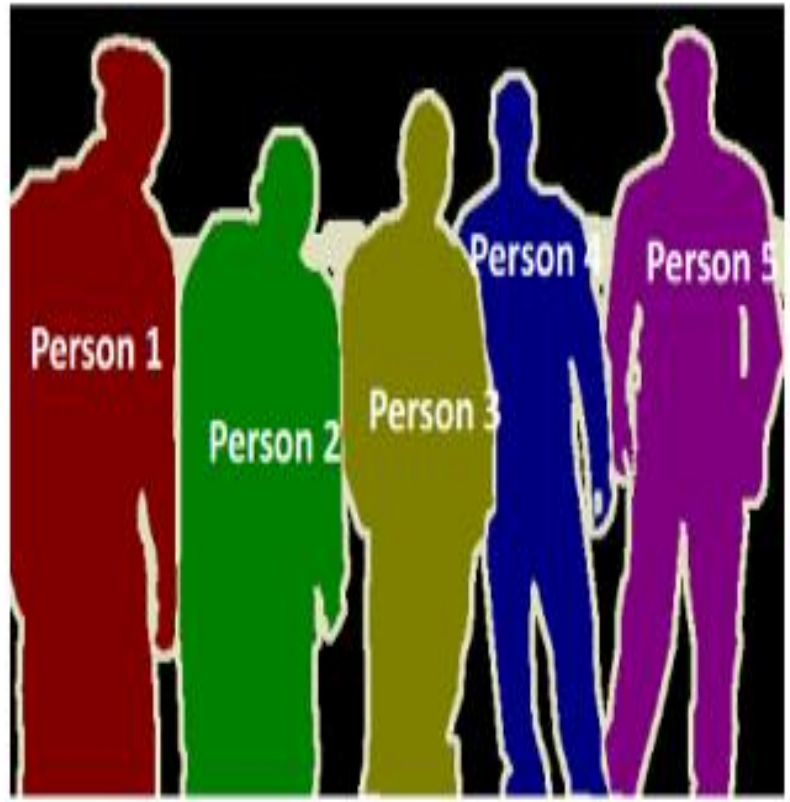
Semantic Segmentation

predict

Person
Bicycle
Background

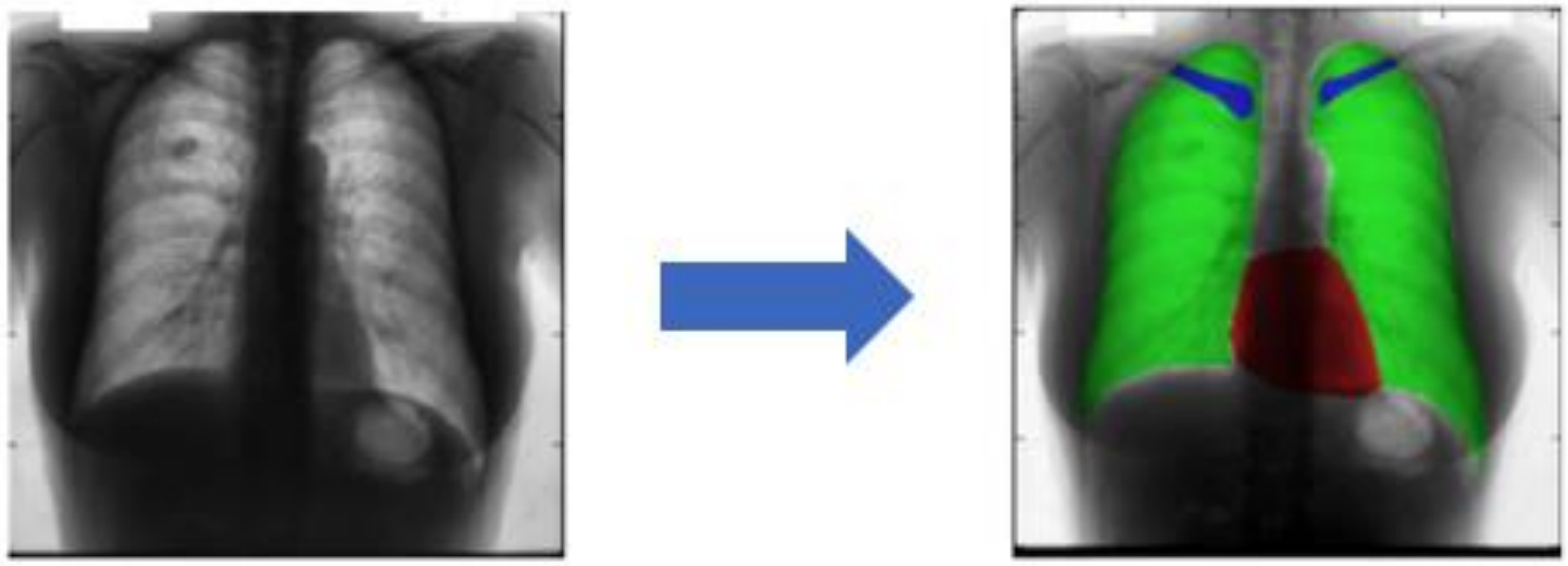
Object Detection

Semantic Segmentation



Instance Segmentation

Segmentation in Medical Image



Input Image

Segmented Image

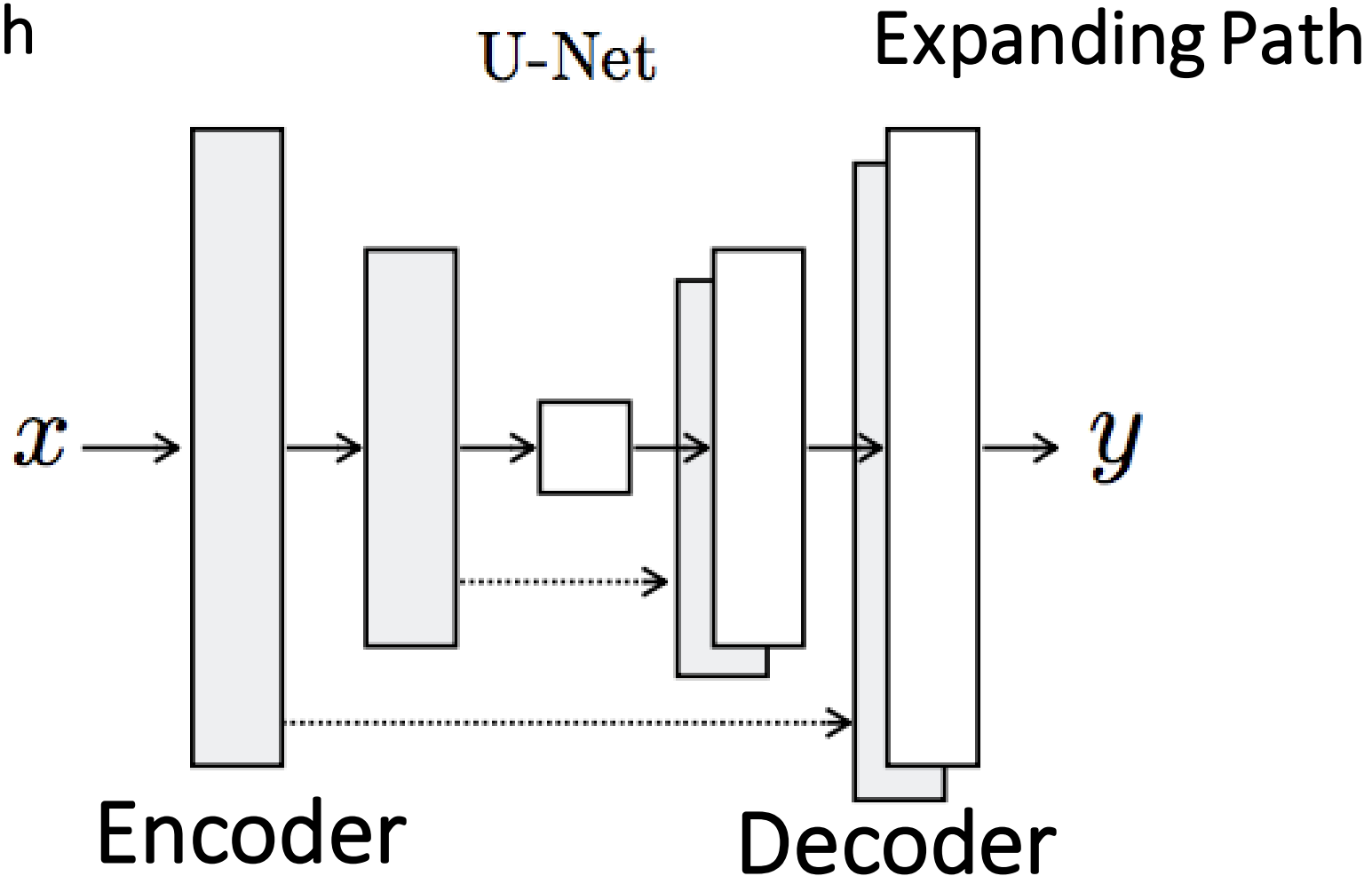
The Unet Architecture

The ***UNET*** was developed by Olaf Ronneberger et al. for Bio Medical Image Segmentation.

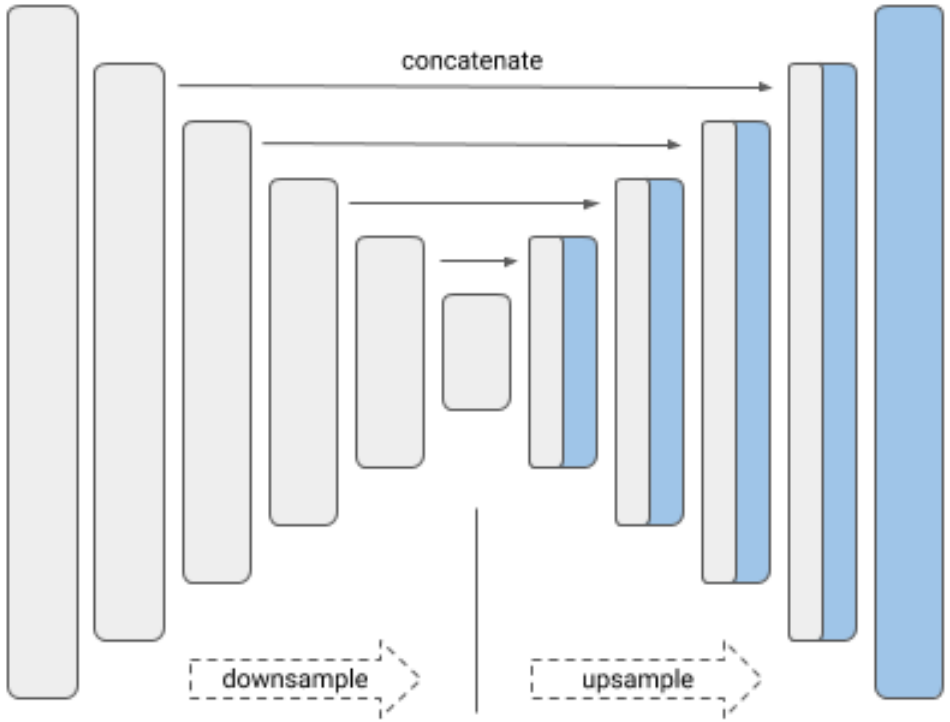
https://arxiv.org/abs/1505.04597

Unet -“fully convolutional network”

Contraction Path



Two major Operations



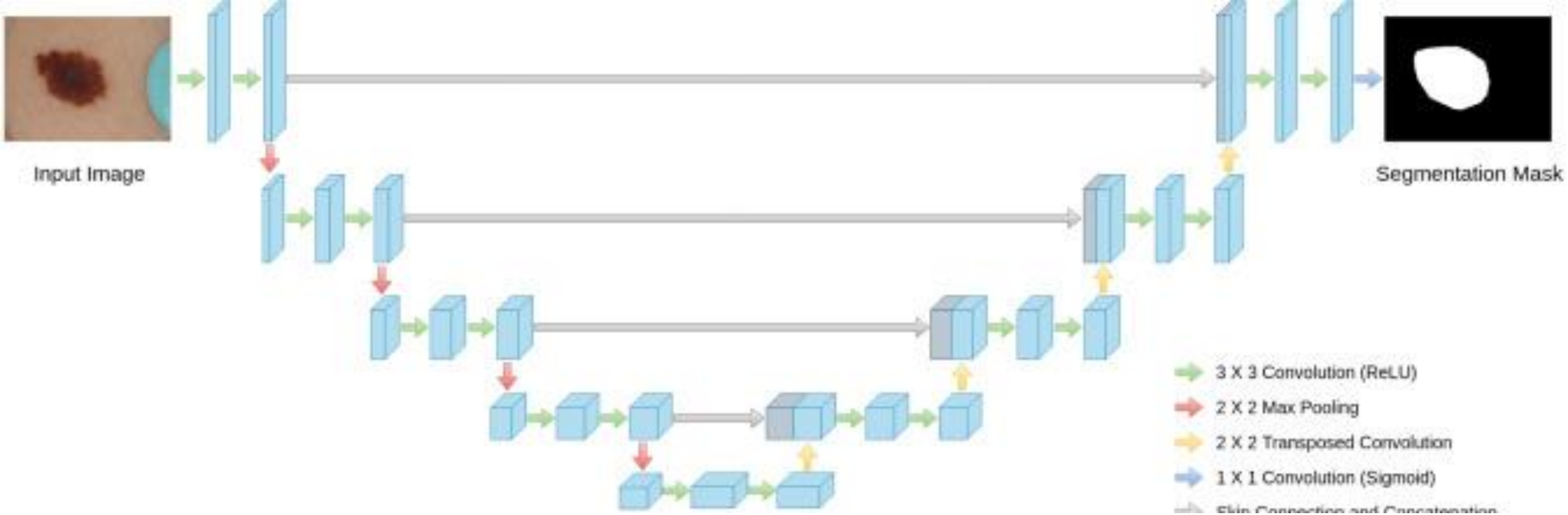
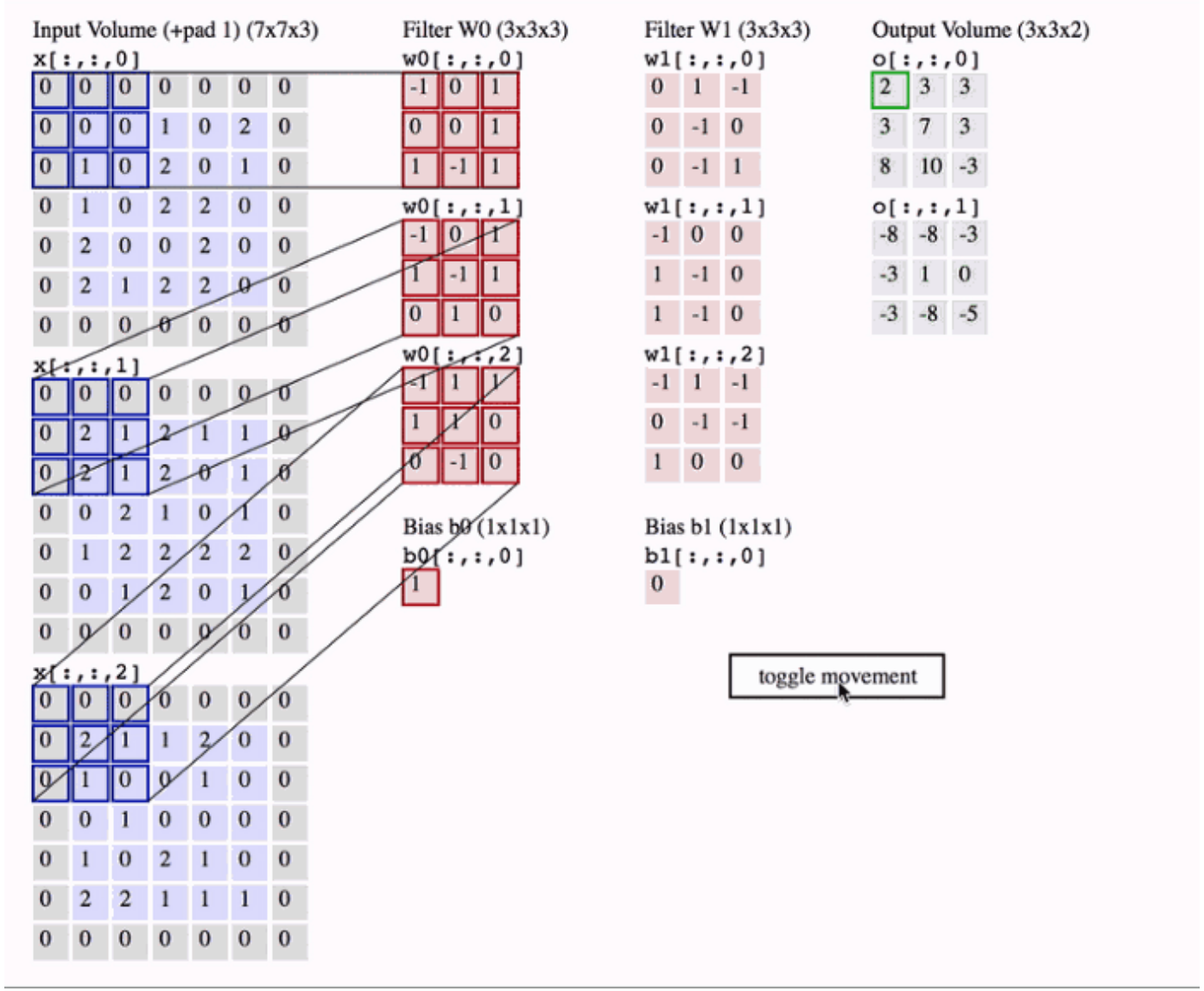


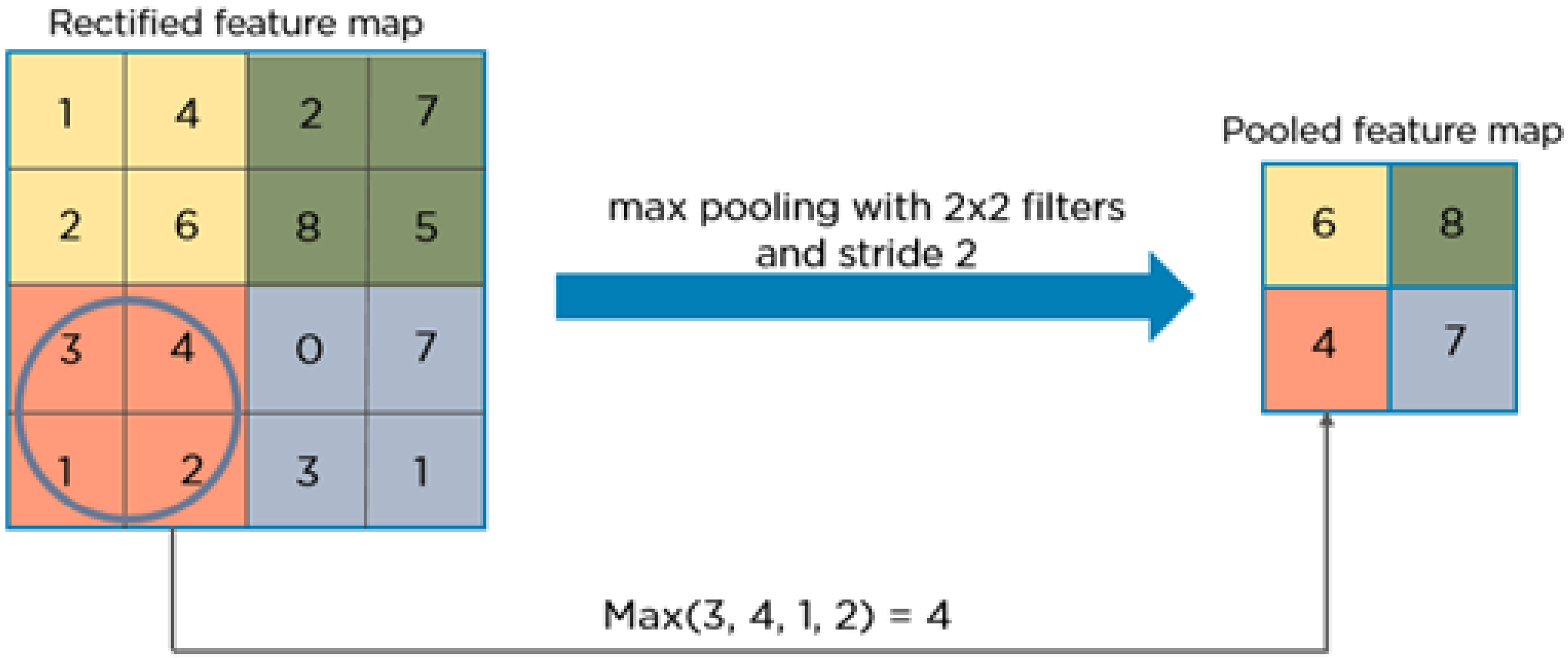
Image to Mask

- **3x3 Convolution (ReLu)**
- **2x2 Max Pooling**
- **2x2 Transposed Convolution**
- **1 x 1 Convolution (Sigmoid)**
- **Skip Connections and Concatinations**

Convolution Operation



Max-Pooling


Rectified feature map
1 4 2 7
2 6 8 5
3 4 0 7
1 2 3 1
max pooling with 2x2 filters
and stride 2
Pooled feature map
6 8
4 7
Max(3, 4, 1, 2) = 4

Transposed convolution

1	2	3
6	5	3
1	4	1

3x3 Input

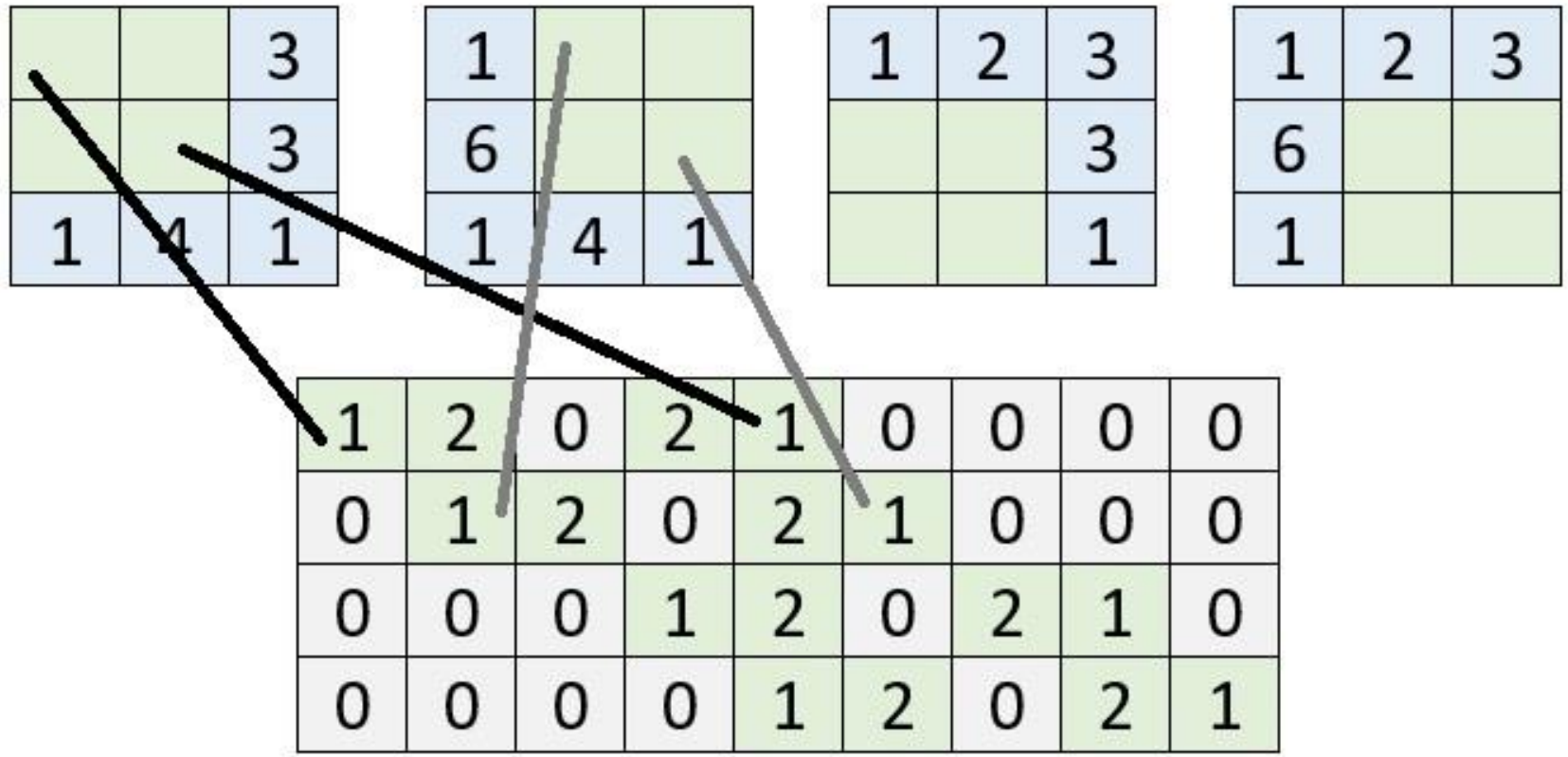
1	2
2	1

2x2 Kernel

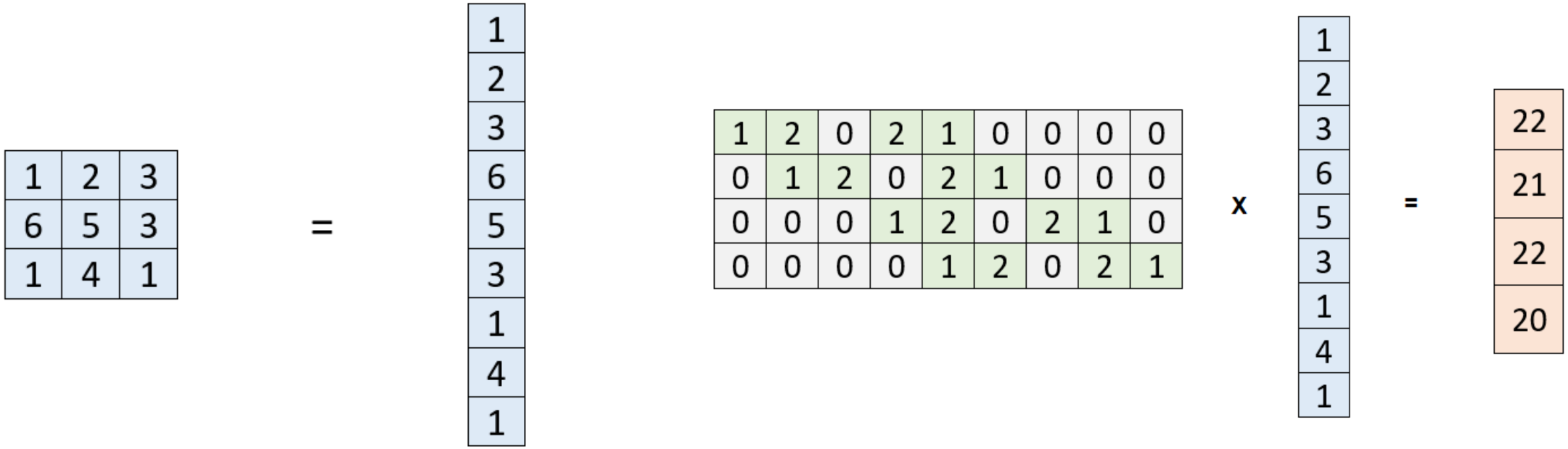
22	21
22	20

Eg. Of Normal Convolution

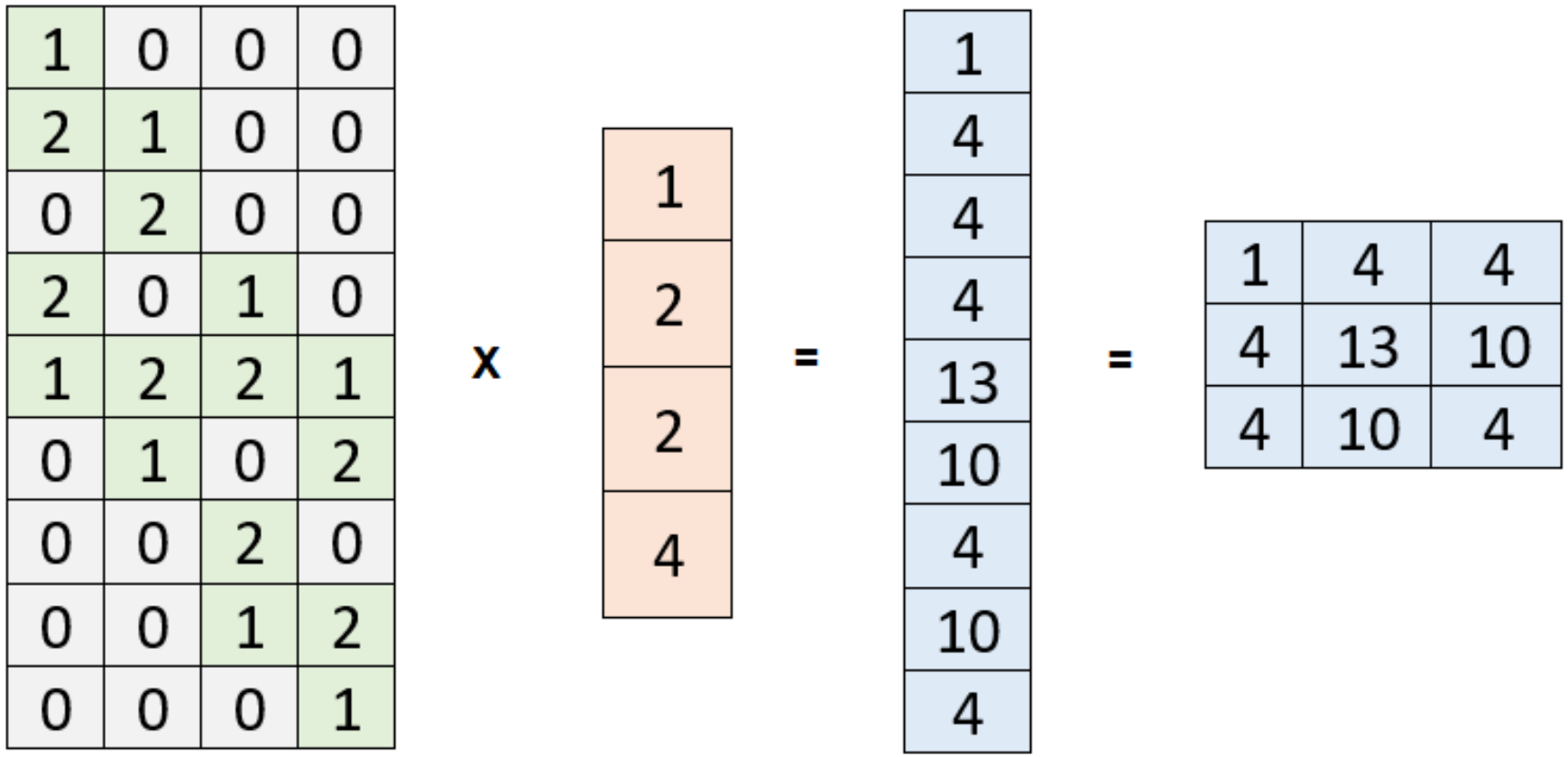
Making Convolution Matrix



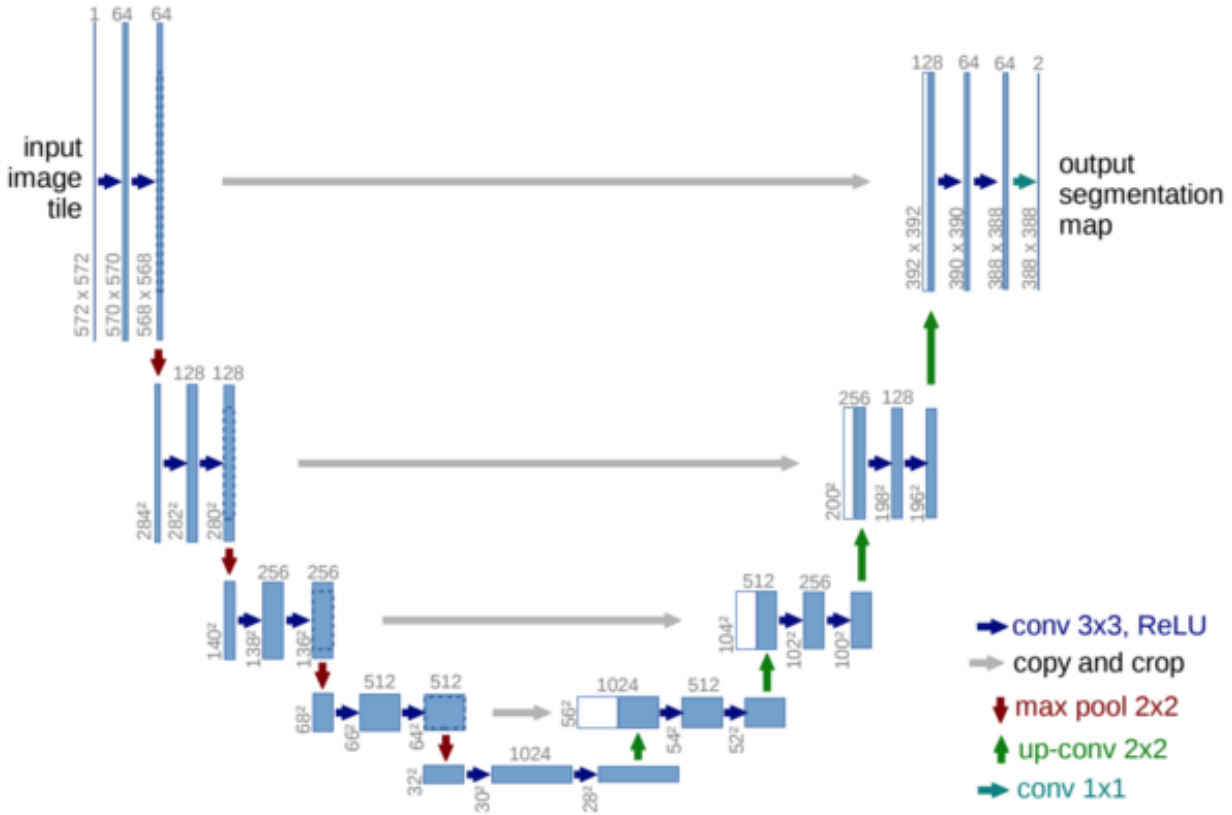
Compute Output with Convlution matrix



Transpose Convolution



Final Architecture - UNET

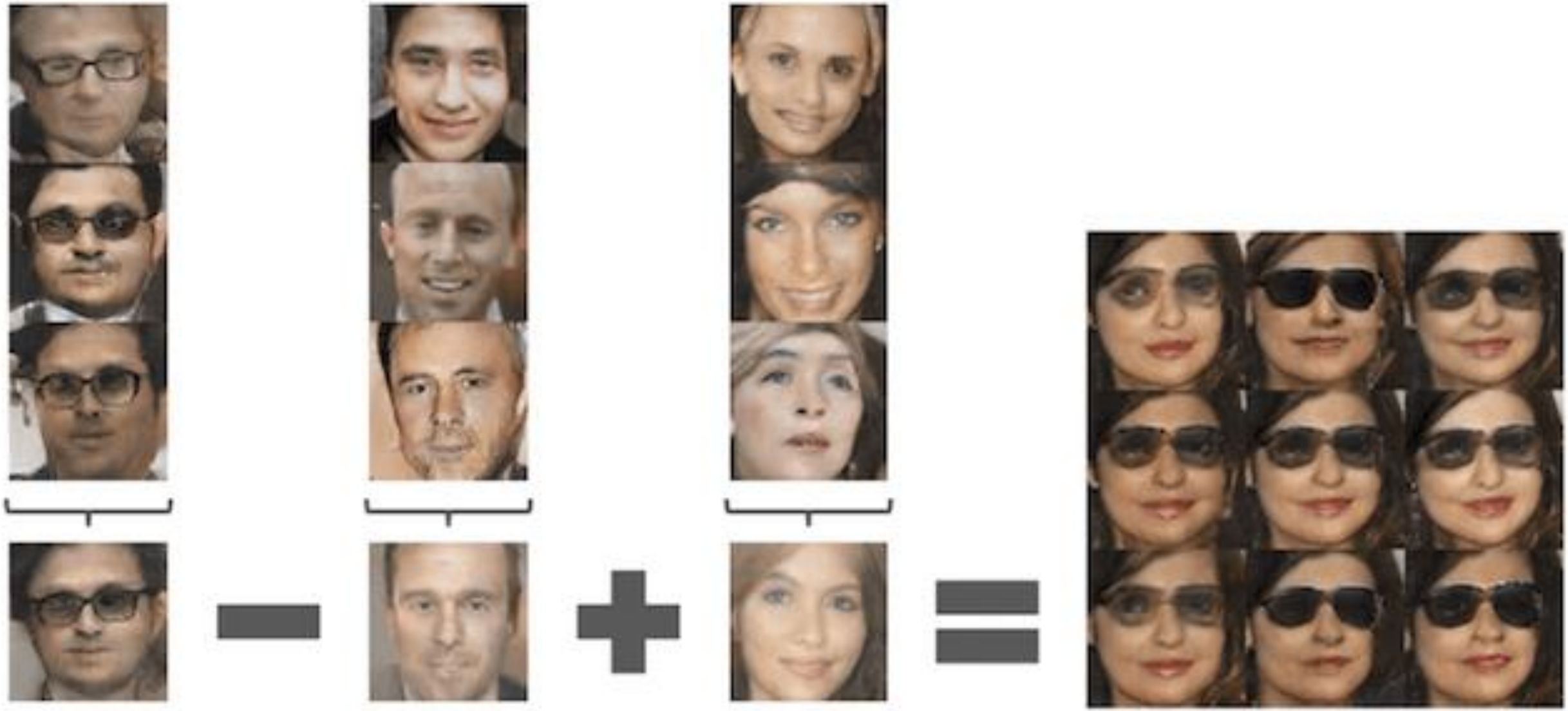


Let's see the implementation


GAN & Computer Vision
Applications
Let's Begin the Journey

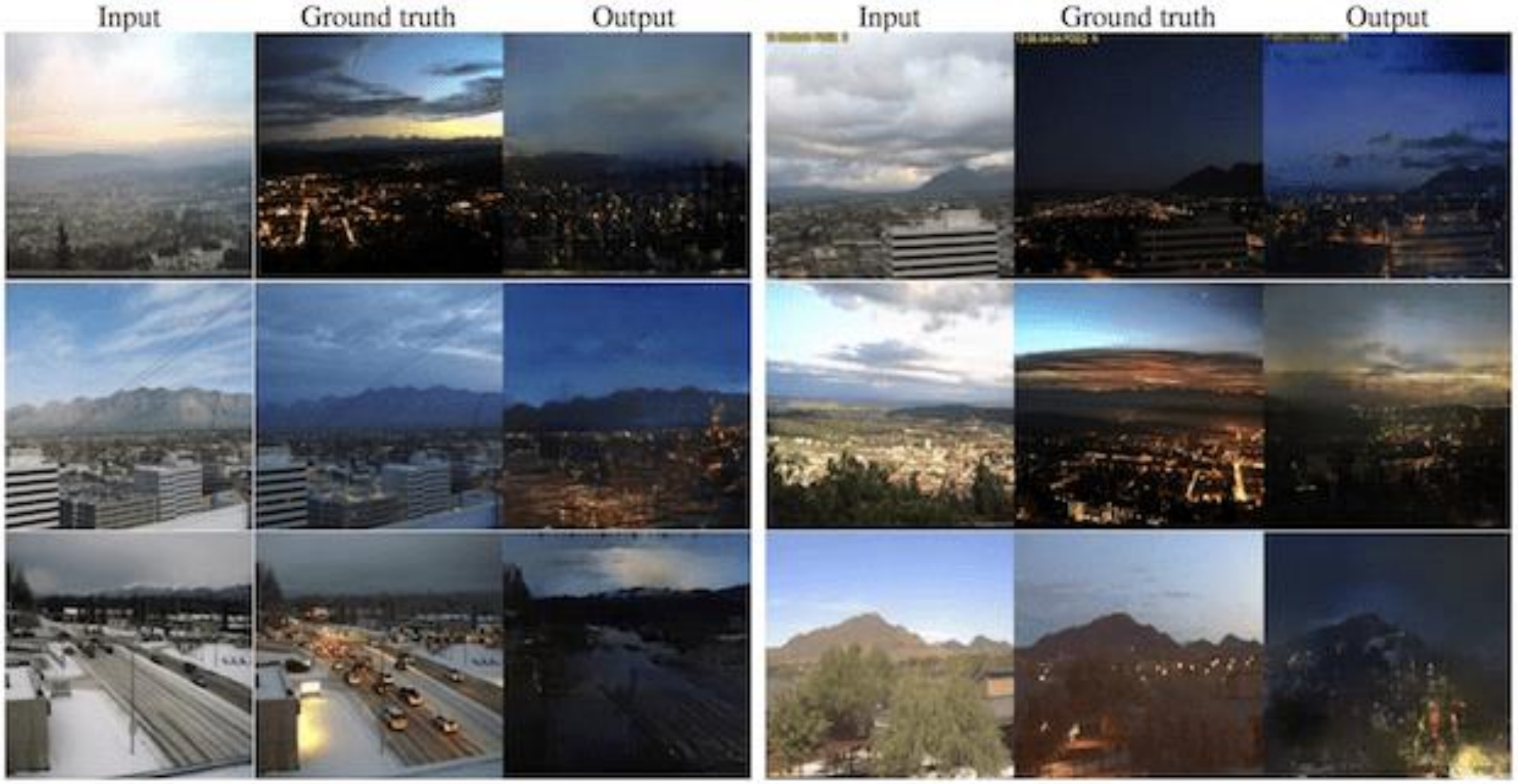
GAN Applications

- Generate Examples for Image Datasets
- Generate Photographs of Human Faces
- Generate Realistic Photographs
- Generate Cartoon Characters
- Image-to-Image Translation
- Text-to-Image Translation
- Clothing Translation
- Video Prediction
- 3D Object Generation
- Semantic-Image-to-Photo Translation
- Face Frontal View Generation
- Generate New Human Poses
- Photos to Emojis
- Photograph Editing
- Face Aging
- Photo Blending
- Super Resolution
- Photo Inpainting

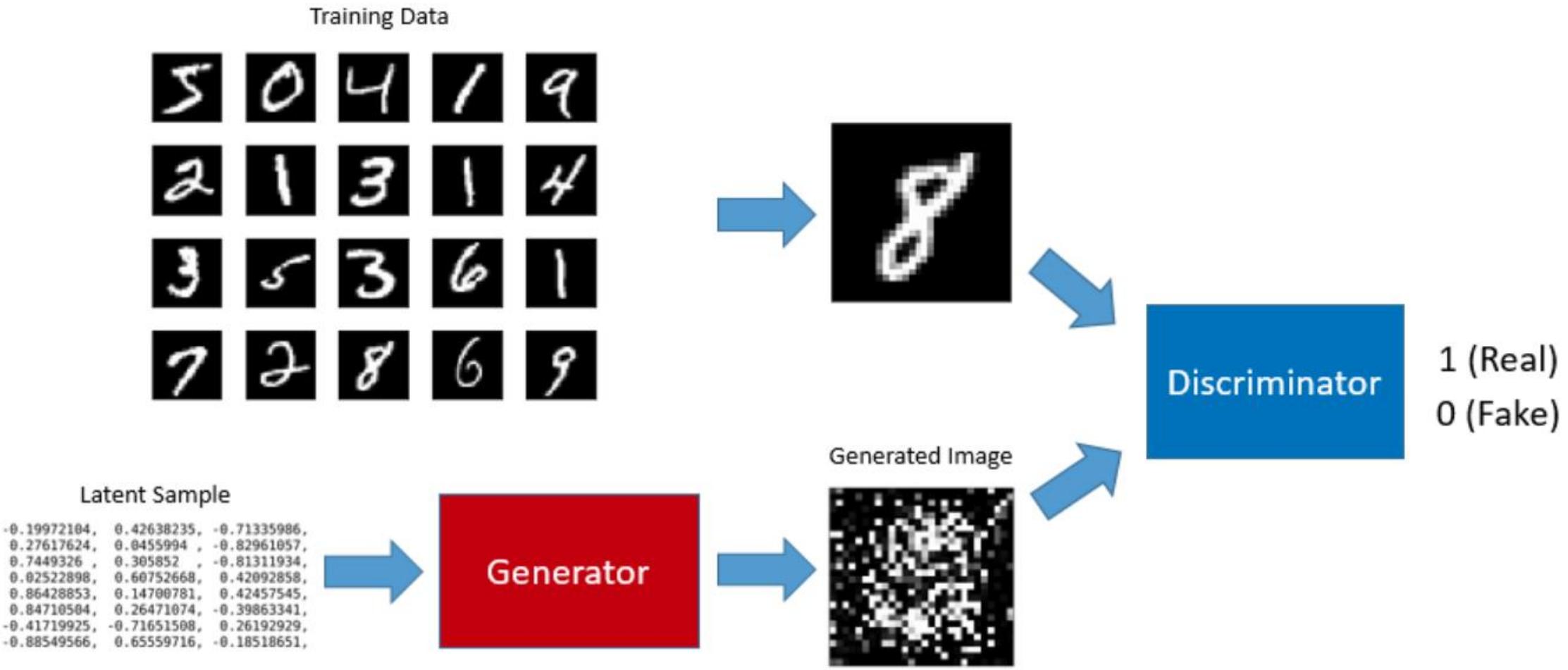

man
with glasses
man
without glasses
woman
without glasses
woman with glasses

Face aging using GAN

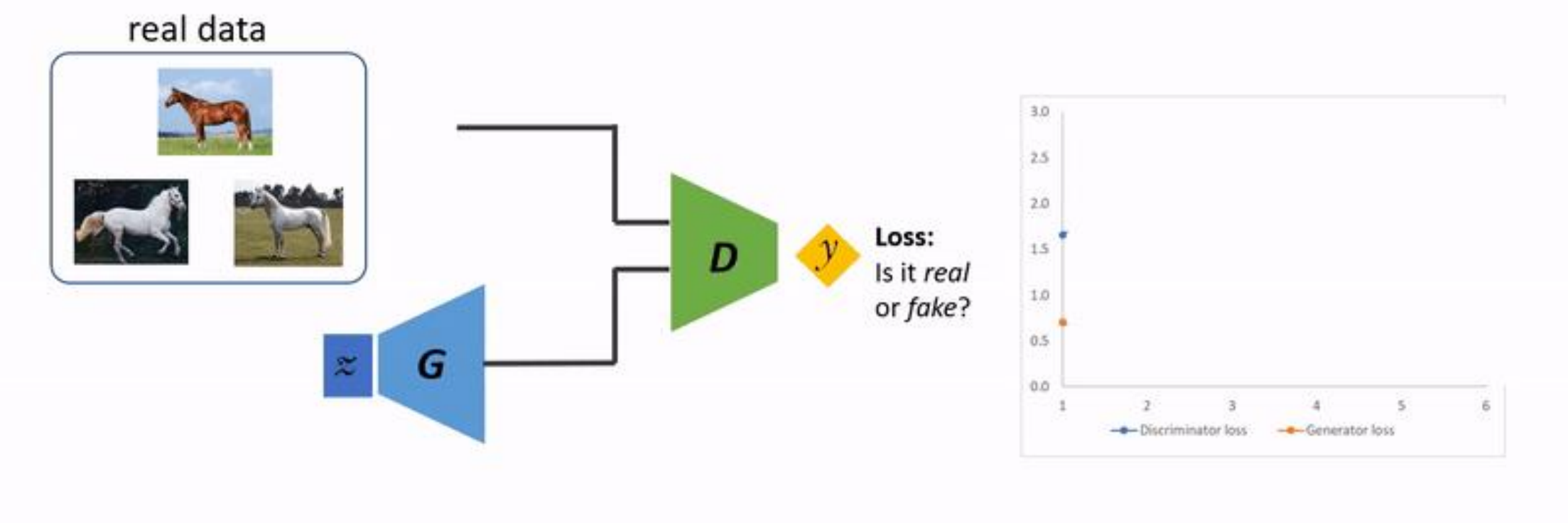
Image to Image Translation – Day to Night



How GAN Works

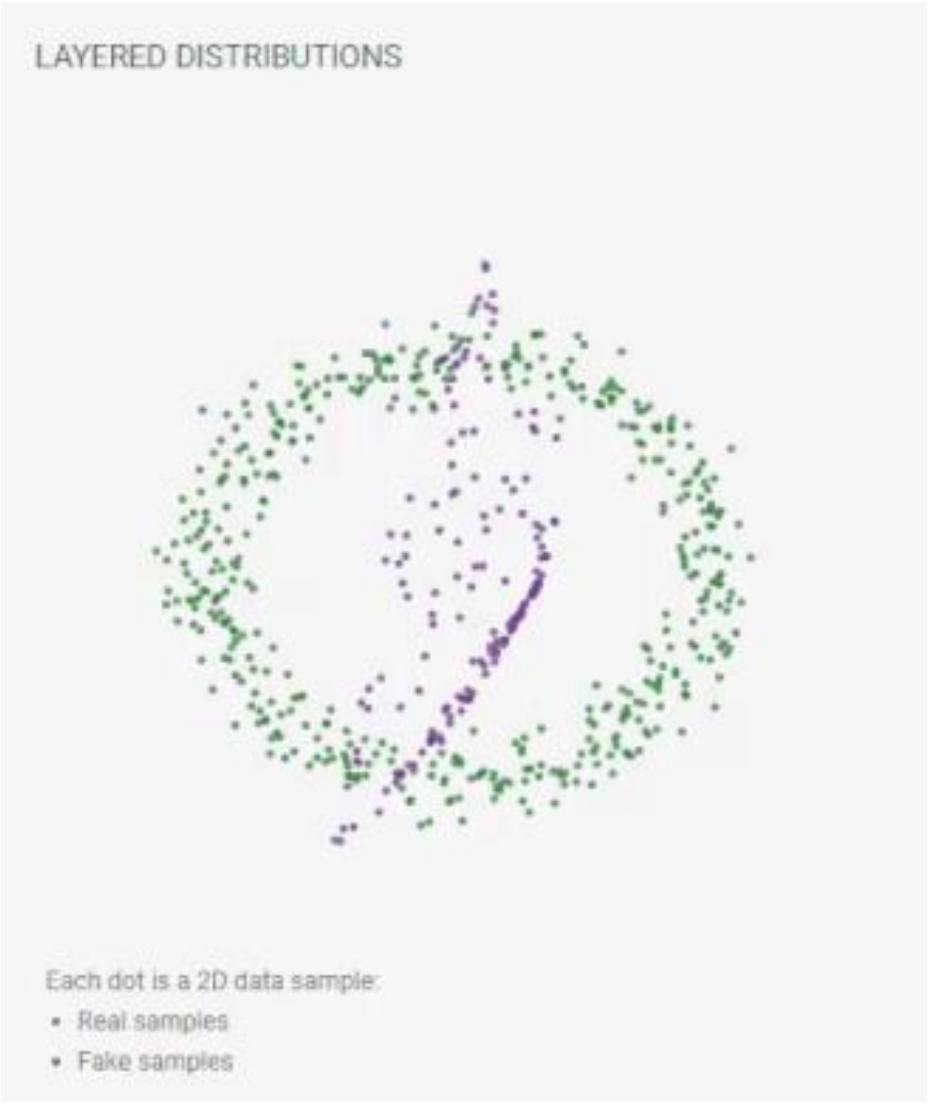


How GAN Works

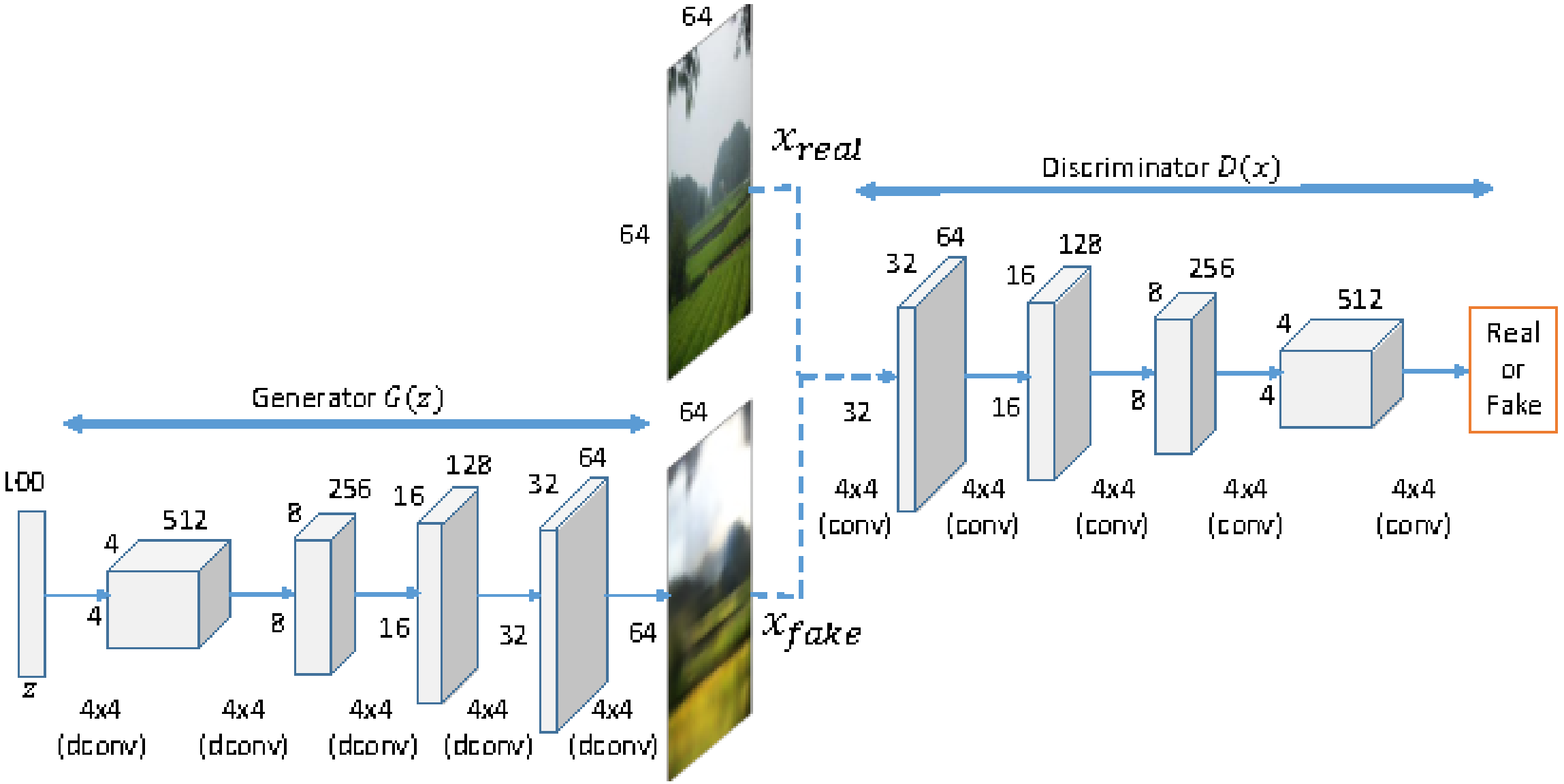


The generator learns the data distribution

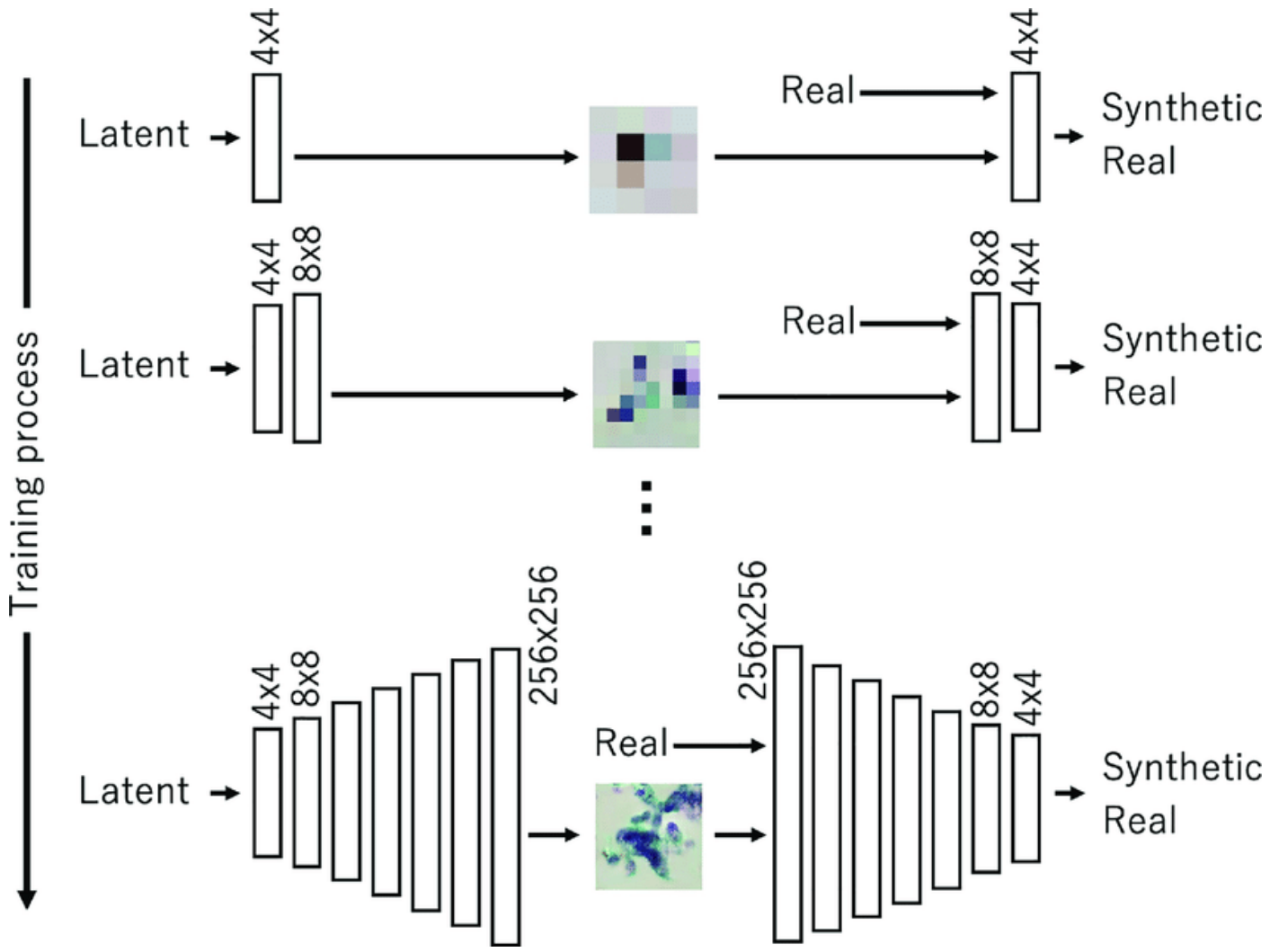
- Credits : GANLAB



GAN Networks



GAN Training Progress



- You can have your own architectures for generator and Discriminator

Let's Explore GAN implementation Using Python

Thank You