Version : 1.2

Quand l'essentiel tient en si peu de choses :-)

Ou, la magie des espaces latents...

Un exemple d'apprentissage non supervisé.

FIDLE

Journée GRICAD - 3 novembre 2020

Soraya ARIAS – INRIA
Eric MALDONADO – INRAE
Jean-Luc PAROUTY – SIMaP

Thanks to :

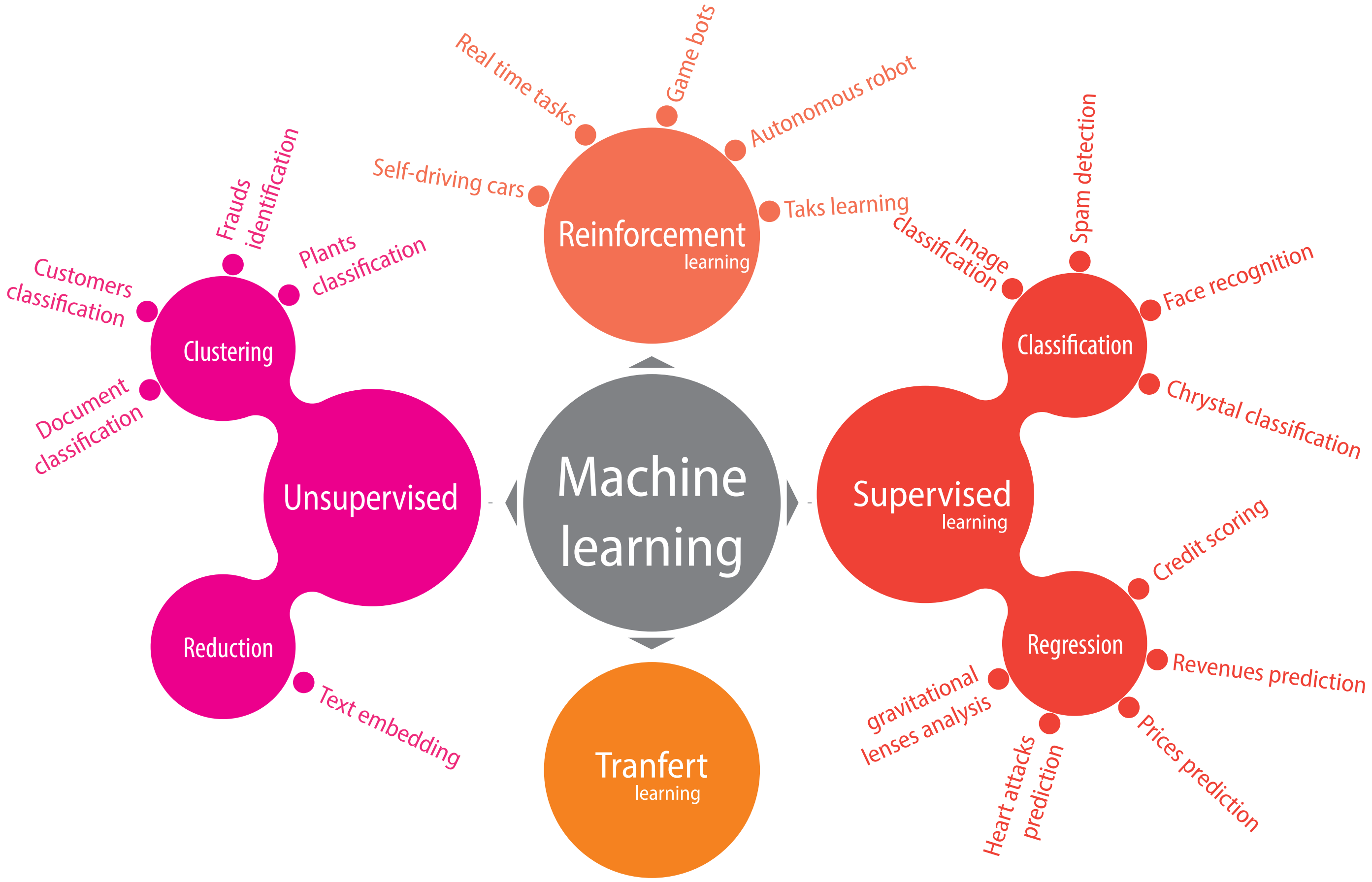
GRICAD cnrs IDRIS

✌ Remember that **Bigfoot** and **Jean-Zay** are good for you !

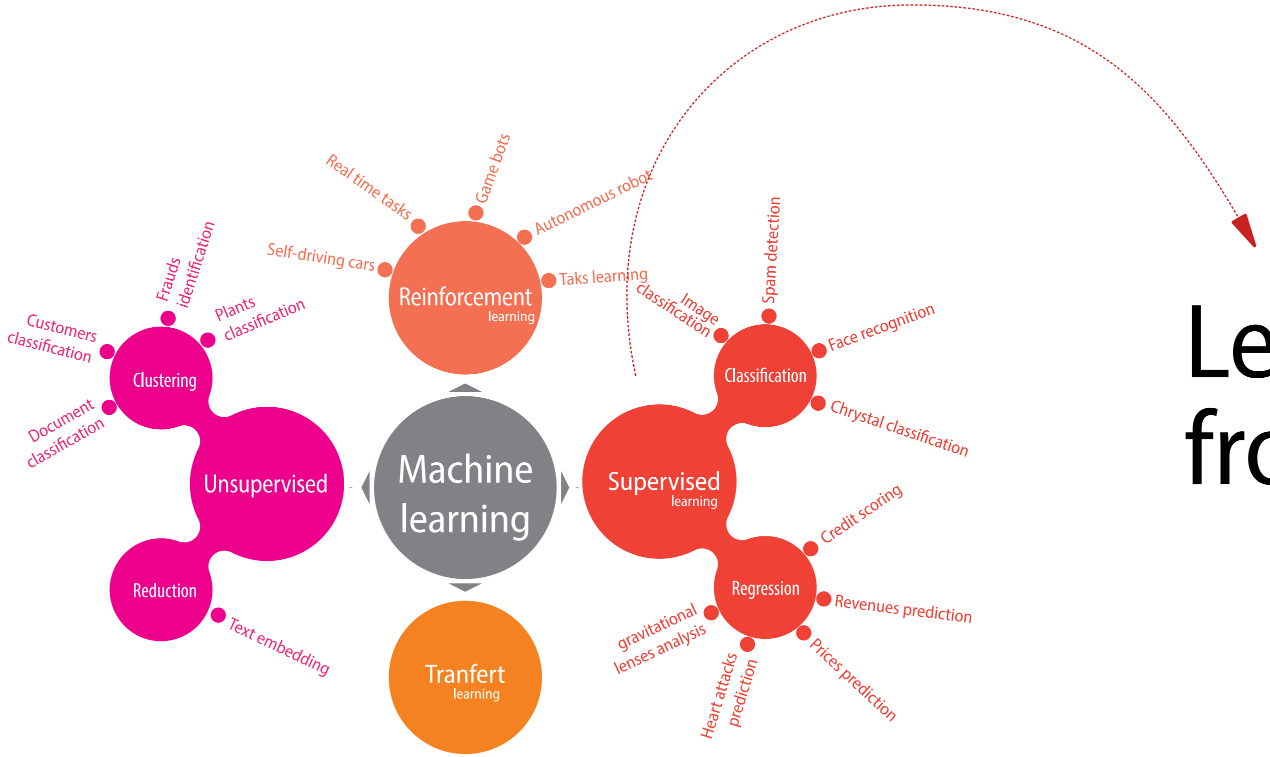
Cooking Ingredients :

python™ NumPy TensorFlow K Keras matplotlib jupyter

[*-learning]


Machine learning
Reinforcement learning
Real time tasks
Game bots
Autonomous robot
Self-driving cars
Taks learning
Unsupervised
Clustering
Frauds identification
Plants classification
Customers classification
Document classification
Reduction
Text embedding
Supervised learning
Classification
Image classification
Spam detection
Face recognition
Chrystal classification
Regression
Credit scoring
Revenues prediction
gravitational lenses analysis
Heart attacks prediction
Prices prediction
Tranfert learning

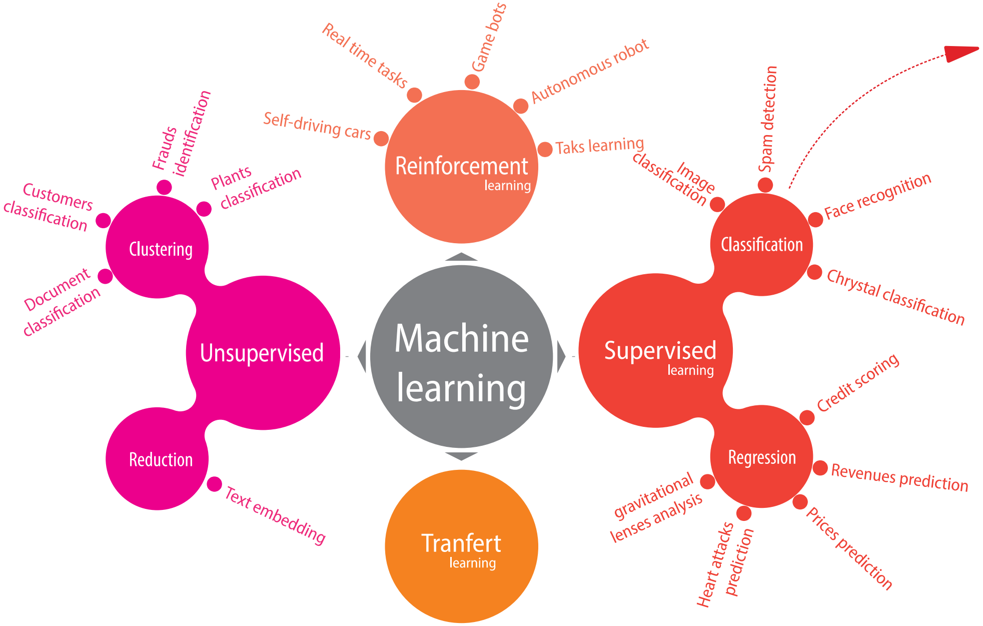
Supervised learning



Learning from **examples**

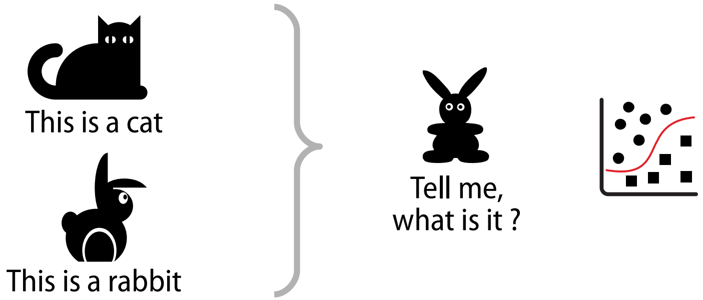
Supervised learning

Learning from examples



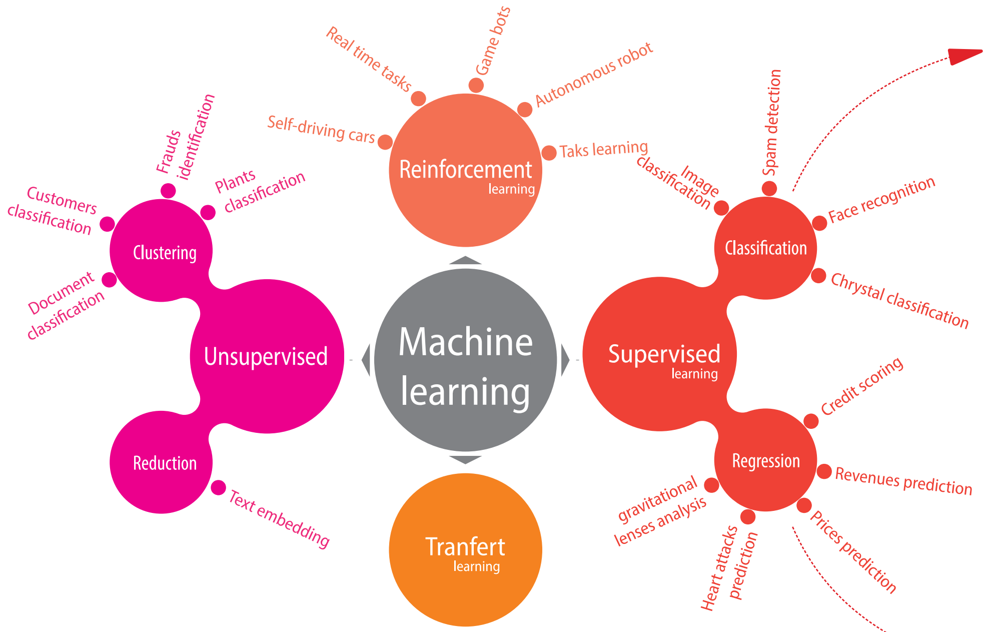
Classification :

Predict qualitative informations



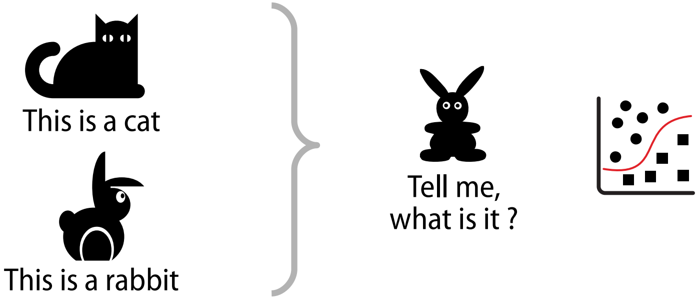
Supervised learning

Learning from examples



Classification :

Predict qualitative informations



This is a cat

This is a rabbit

Tell me, what is it ?

Régression :

Predict quantitative informations

150 K€

400 K€

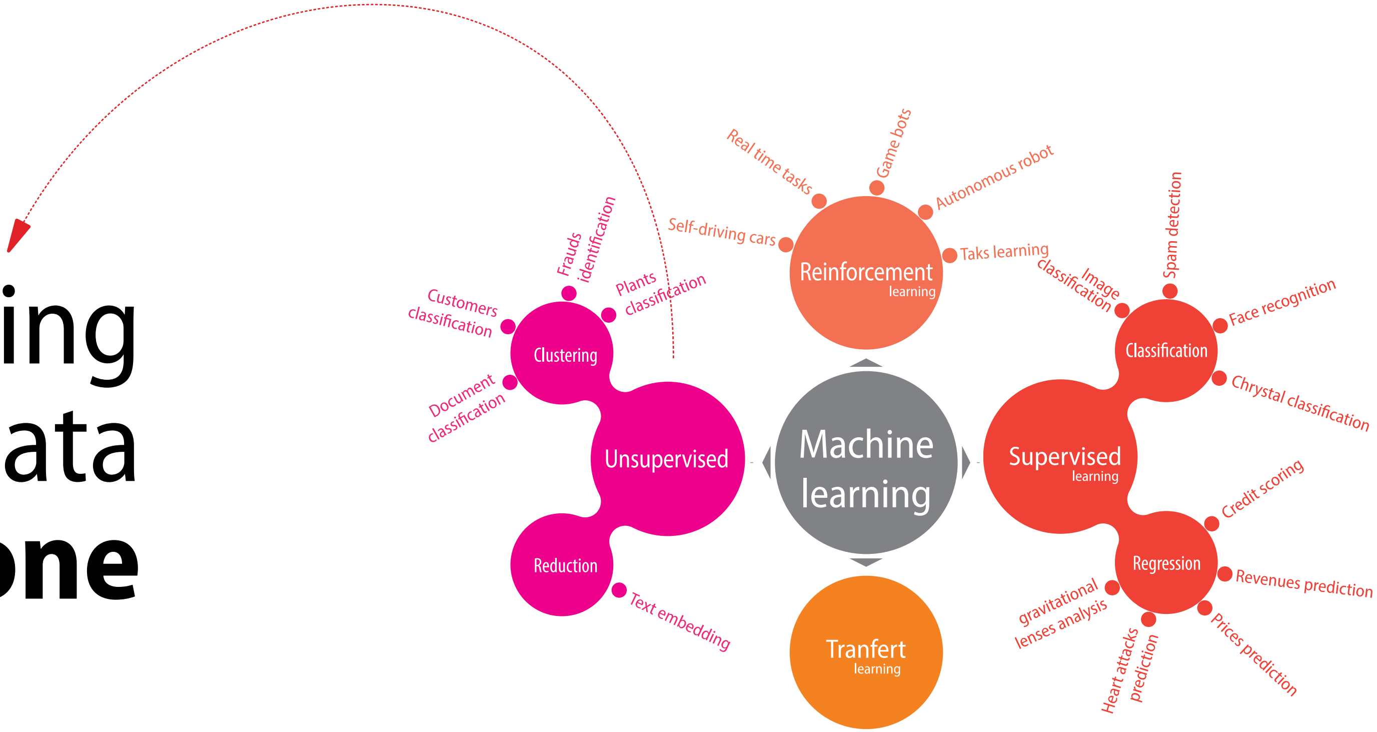
120 K€

100 K€

Tell me, what's the price ?

Unsupervised learning

Learning
from data
alone

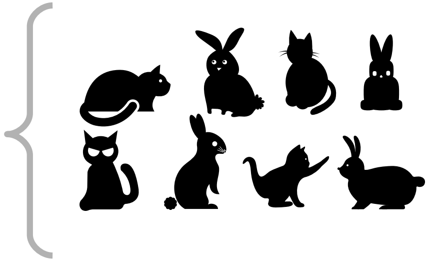


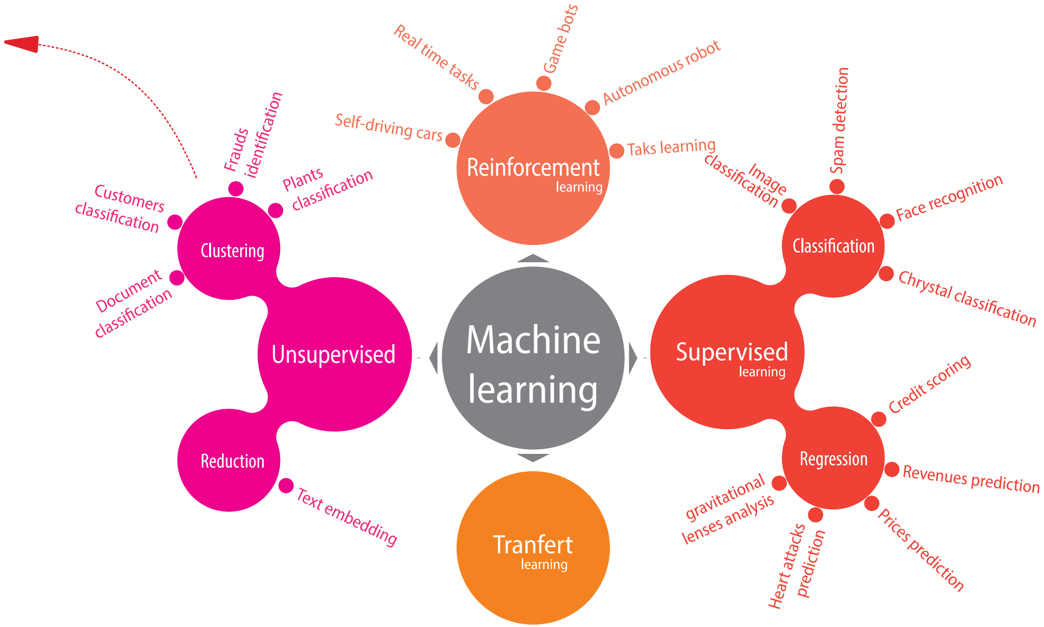
Unsupervised learning

Learning from data alone

Clustering :
Finding Common Relationships

What is the relationship between these data ?



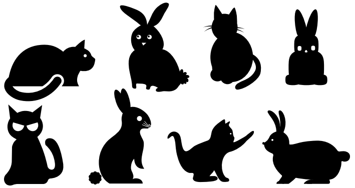


Unsupervised learning

Learning from data alone

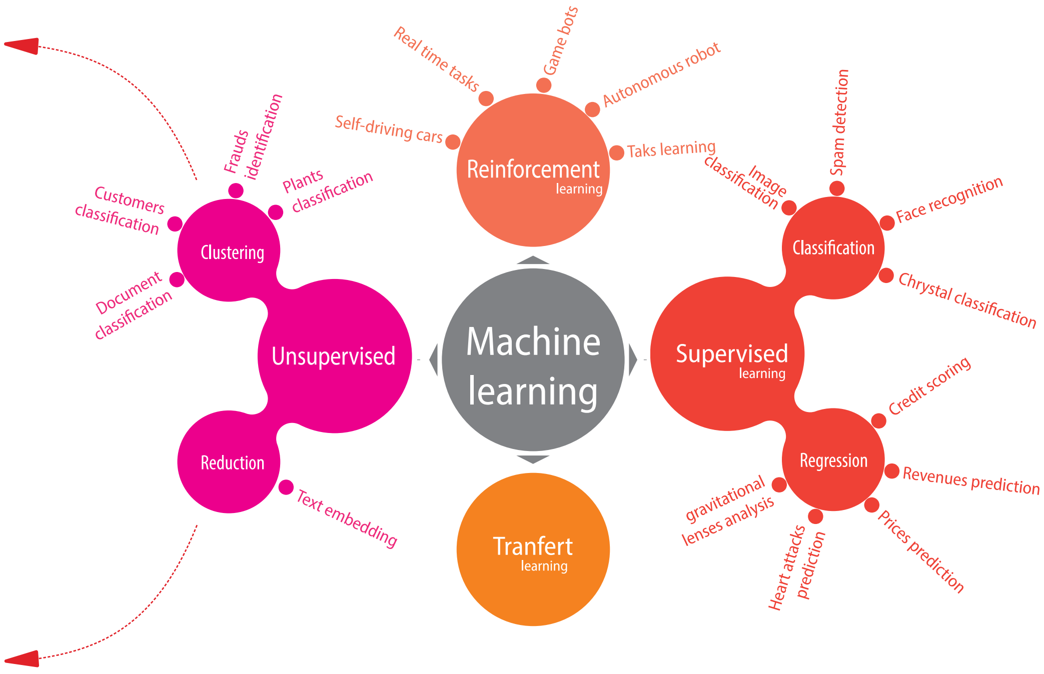
Clustering :
Finding Common Relationships

What is the relationship between these data ?



Reduction :
Reduce the number of dimensions

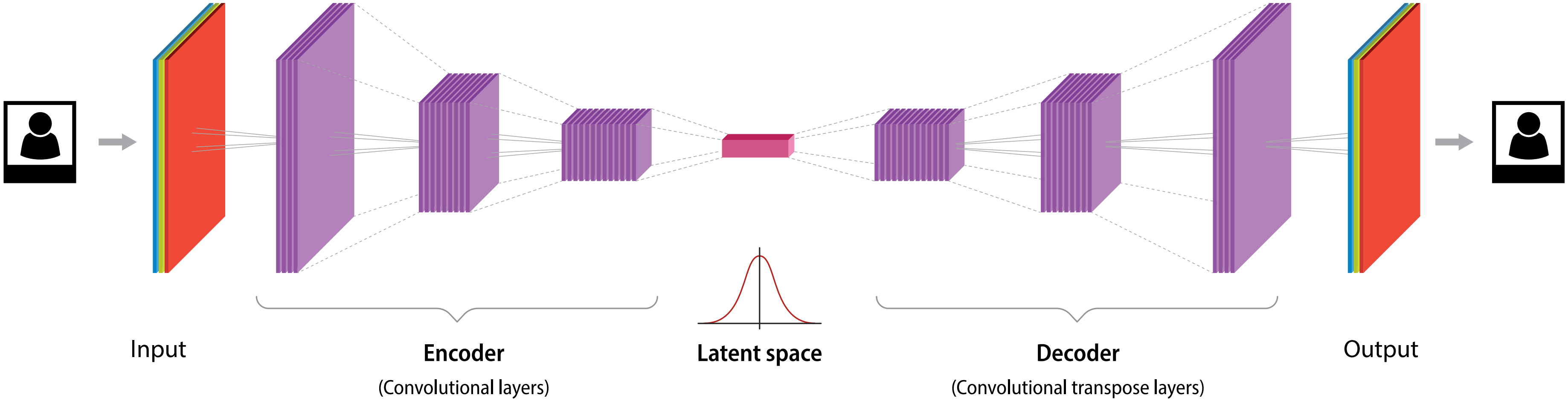
Simplify while keeping meaning



Variational Antoencoder (VAE)

FIDLE

Variational Autoencoder



Input

Encoder

(Convolutional layers)

Latent space

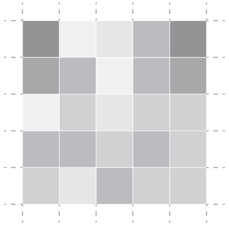
Decoder

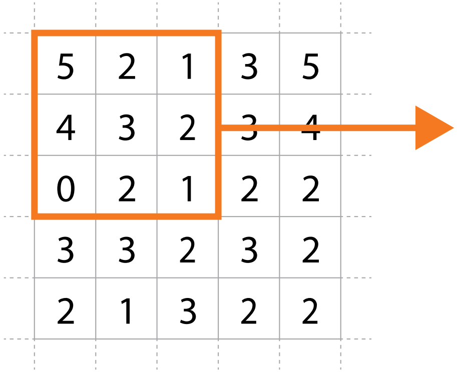
(Convolutional transpose layers)

Output

Encoder

By Jan Kroon, from Pexels.com





5	2	1	3	5
4	3	2	3	4
0	2	1	2	2
3	3	2	3	2
2	1	3	2	2

$$
\begin{array}{ccccc}
\text{Image piece} & & \text{Kernel 3x3} & & \\
\begin{bmatrix} 5 & 2 & 1 \\ 4 & 3 & 2 \\ 0 & 2 & 1 \end{bmatrix} & \otimes & \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 1 \end{bmatrix} & = & \boxed{10} \\
X & & \omega & & y
\end{array}
$$

$$
\begin{aligned}
y \;=\;& 5\text{x}1 + 2\text{x}0 + 1\text{x}1 \\
+\;& 4\text{x}0 + 3\text{x}1 + 2\text{x}0 \\
+\;& 0\text{x}1 + 2\text{x}0 + 1\text{x}1 \;=\; 10
\end{aligned}
$$

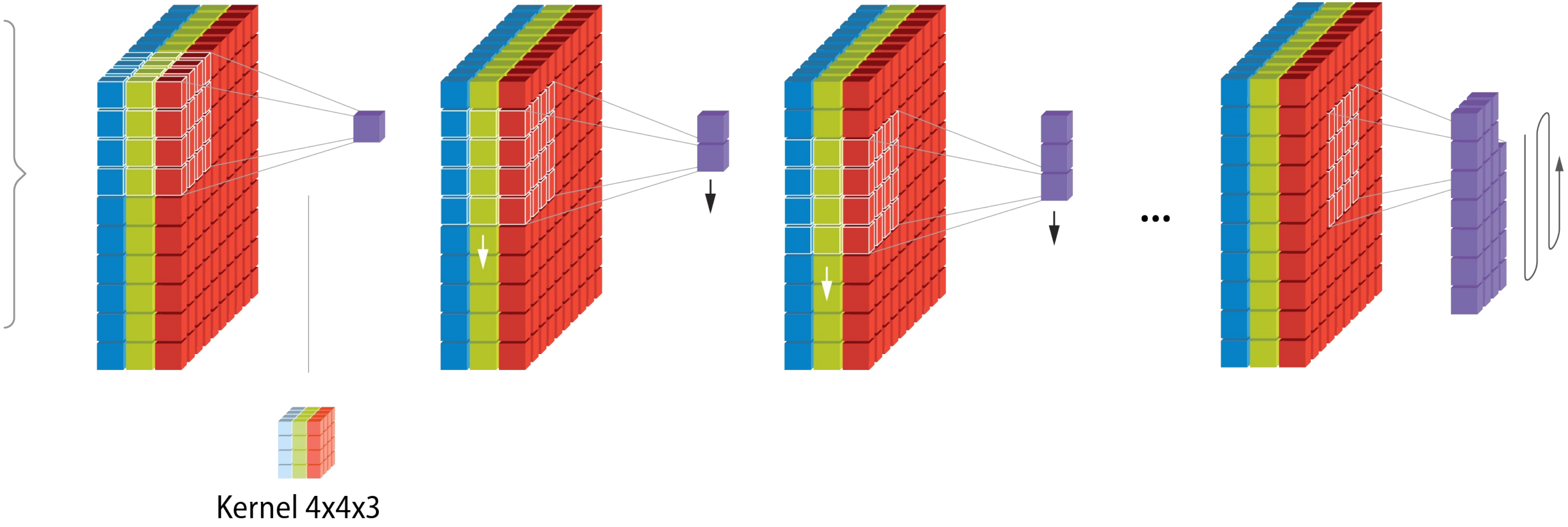
$$
y = \sum_{i=1}^{n} \sum_{j=1}^{m} x_{i,j} \cdot \omega_{i,j} \quad \text{with} \begin{cases} n & \text{kernel width} \\ m & \text{kernel height} \end{cases}
$$

2D convolution

$\otimes$ is Hadamard product

Encoder

By Pixabay From Pexels.com

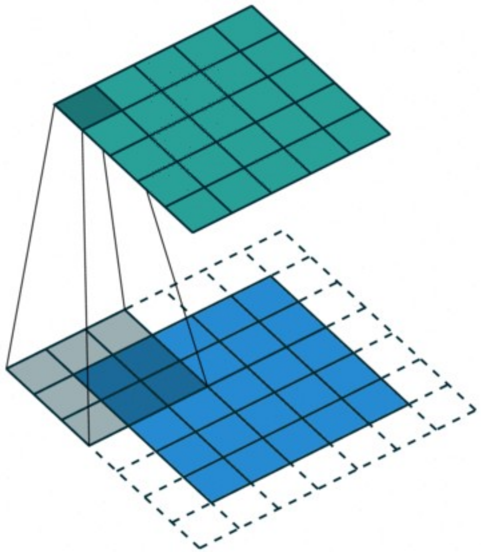


3D convolution

Convolutions

tf.keras.layers.Conv2D

Convolution layer



Original image

Stride
Step size
=> 1

Padding
Active (« same ») or not (« valid »)
=>Active

Kernel
=> 3x3

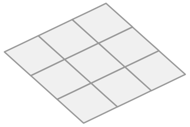


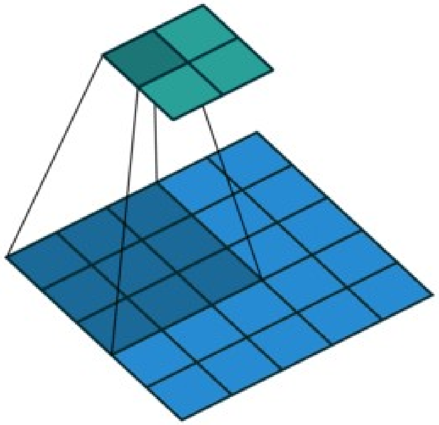
Illustration : An Introduction to different Types of Convolutions in Deep Learning
https://towardsdatascience.com/types-of-convolutions-in-deep-learning-717013397f4d

Convolutions

tf.keras.layers.Conv2D

Convolution layer
(2 x 2)

Original image
(5 x 5)



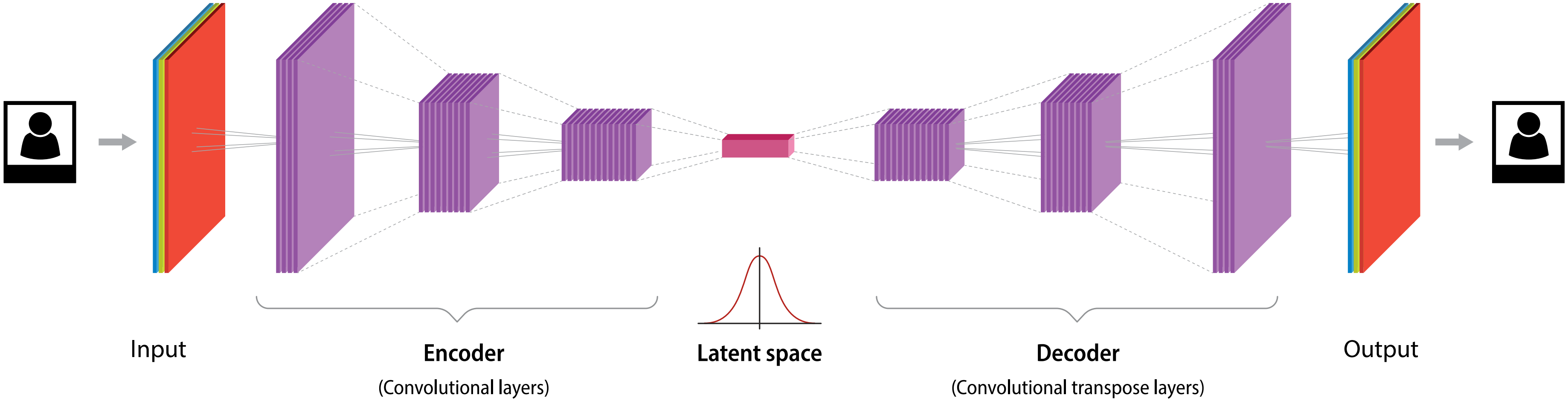
Stride
=>2

Padding
=> Desactivated (« valid »)

Kernel
=> (3,3)

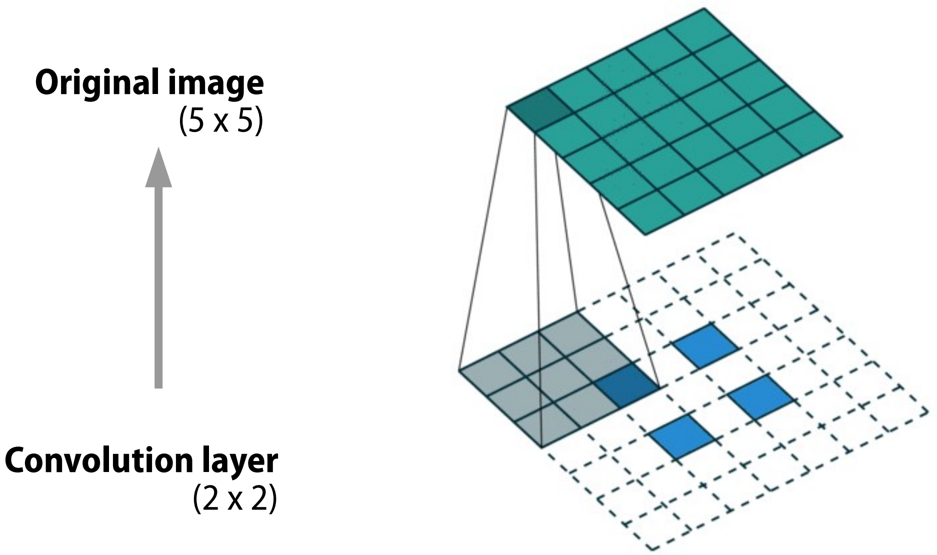
Illustration : An Introduction to different Types of Convolutions in Deep Learning
https://towardsdatascience.com/types-of-convolutions-in-deep-learning-717013397f4d

Variational Autoencoder



Transposed Convolutions

tf.keras.layers.Conv2DTranspose



Stride
Step size

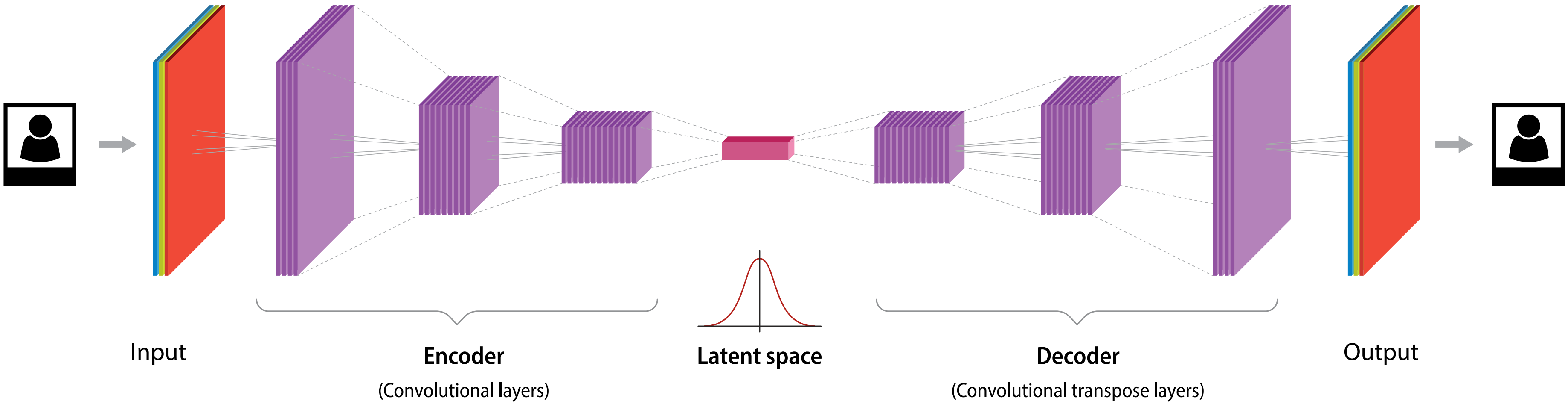
Dilatation rate
Image expansion

Padding
Active or not

Kernel
Kernel size

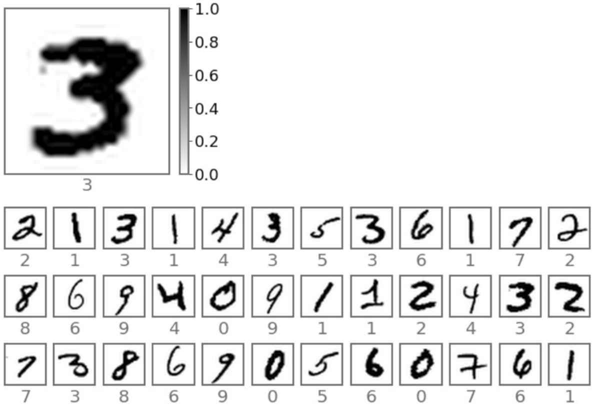
Illustration : An Introduction to different Types of Convolutions in Deep Learning
https://towardsdatascience.com/types-of-convolutions-in-deep-learning-717013397f4d

Variational Autoencoder

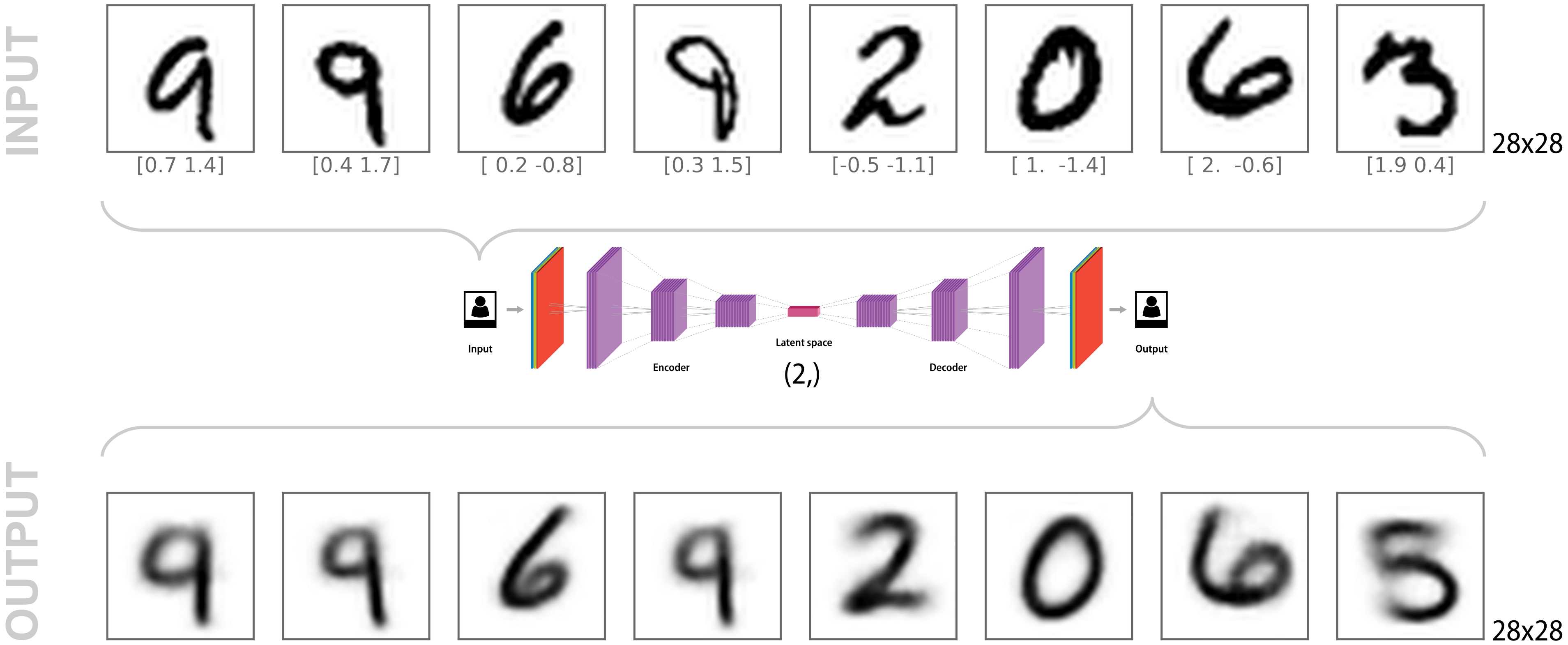


#1

MNIST dataset

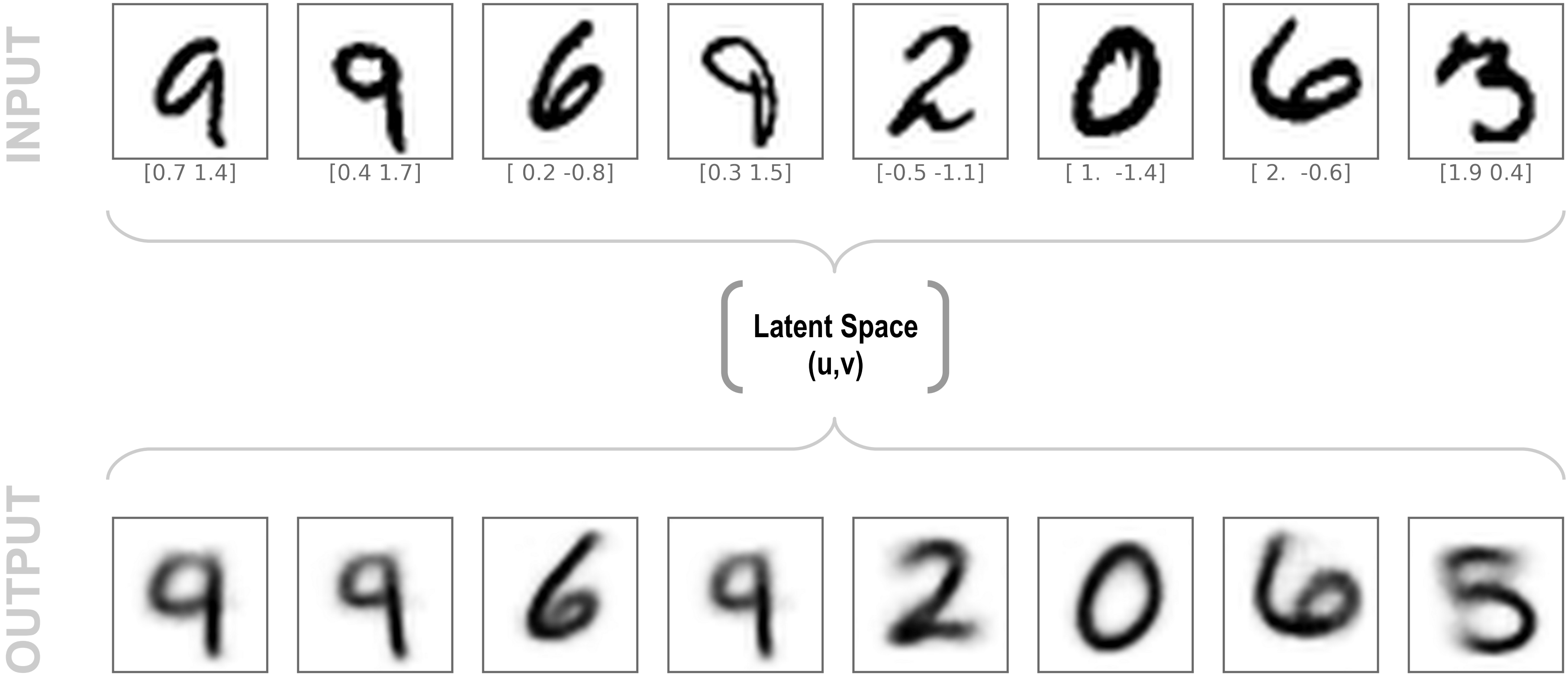


VAE with MNIST



Dataset : 60.000 images, 28x28x1, 50 Mo - Run time : 6’30 on VT100 GPU

VAE with MNIST



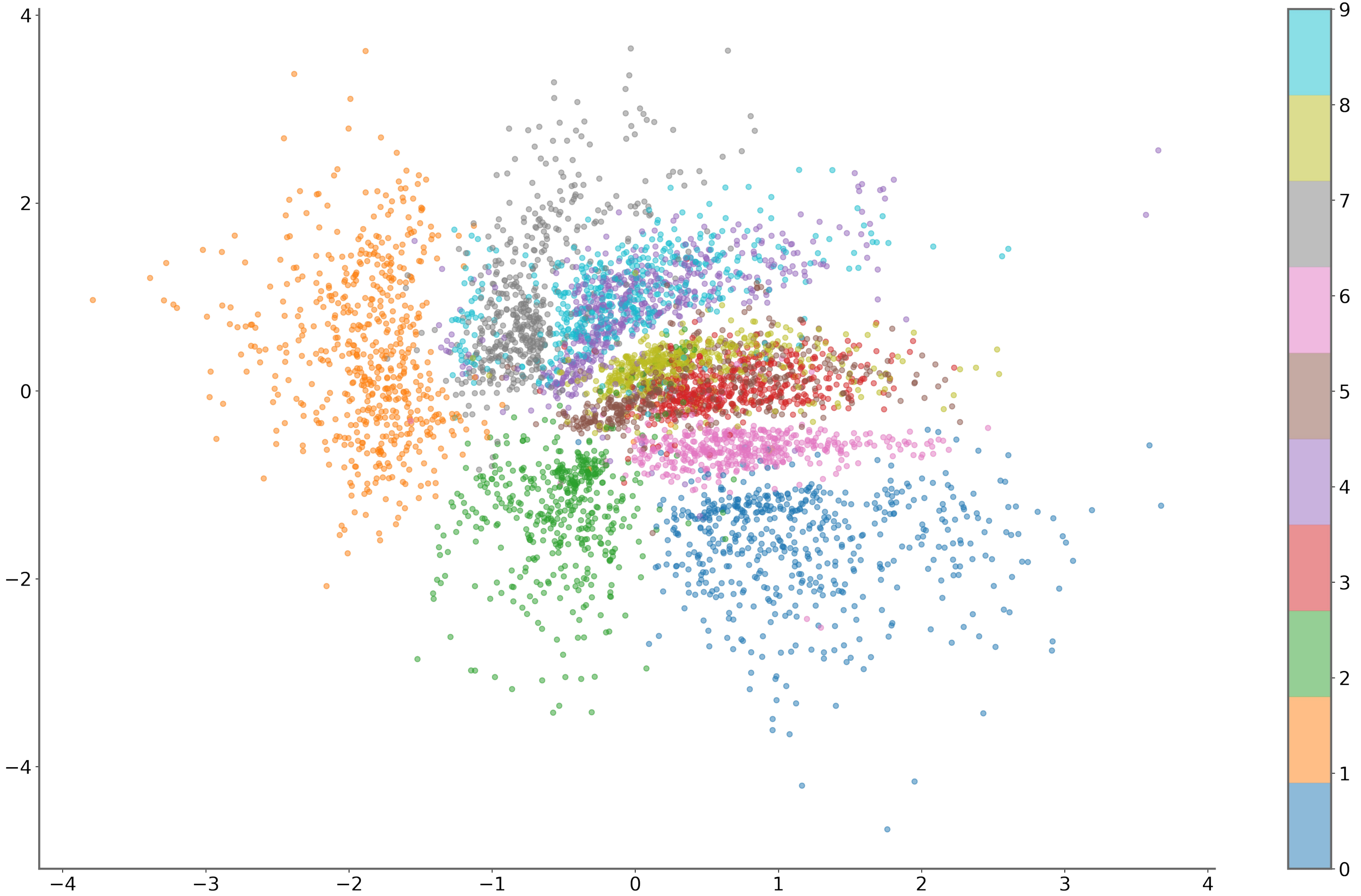
INPUT

[0.7 1.4] [0.4 1.7] [0.2 -0.8] [0.3 1.5] [-0.5 -1.1] [1. -1.4] [2. -0.6] [1.9 0.4]

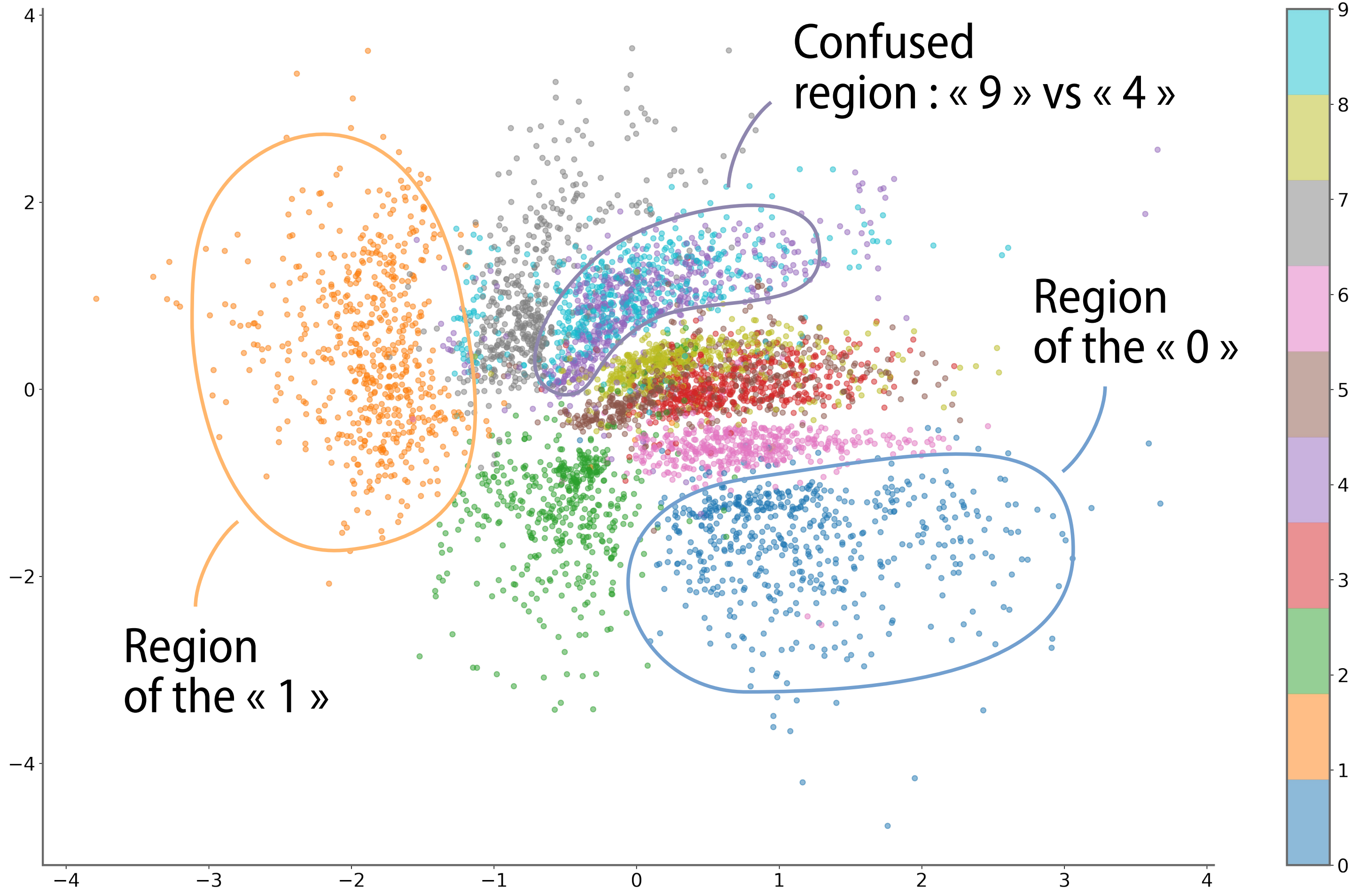
Latent Space
(u,v)

OUTPUT

Latent space



Latent space

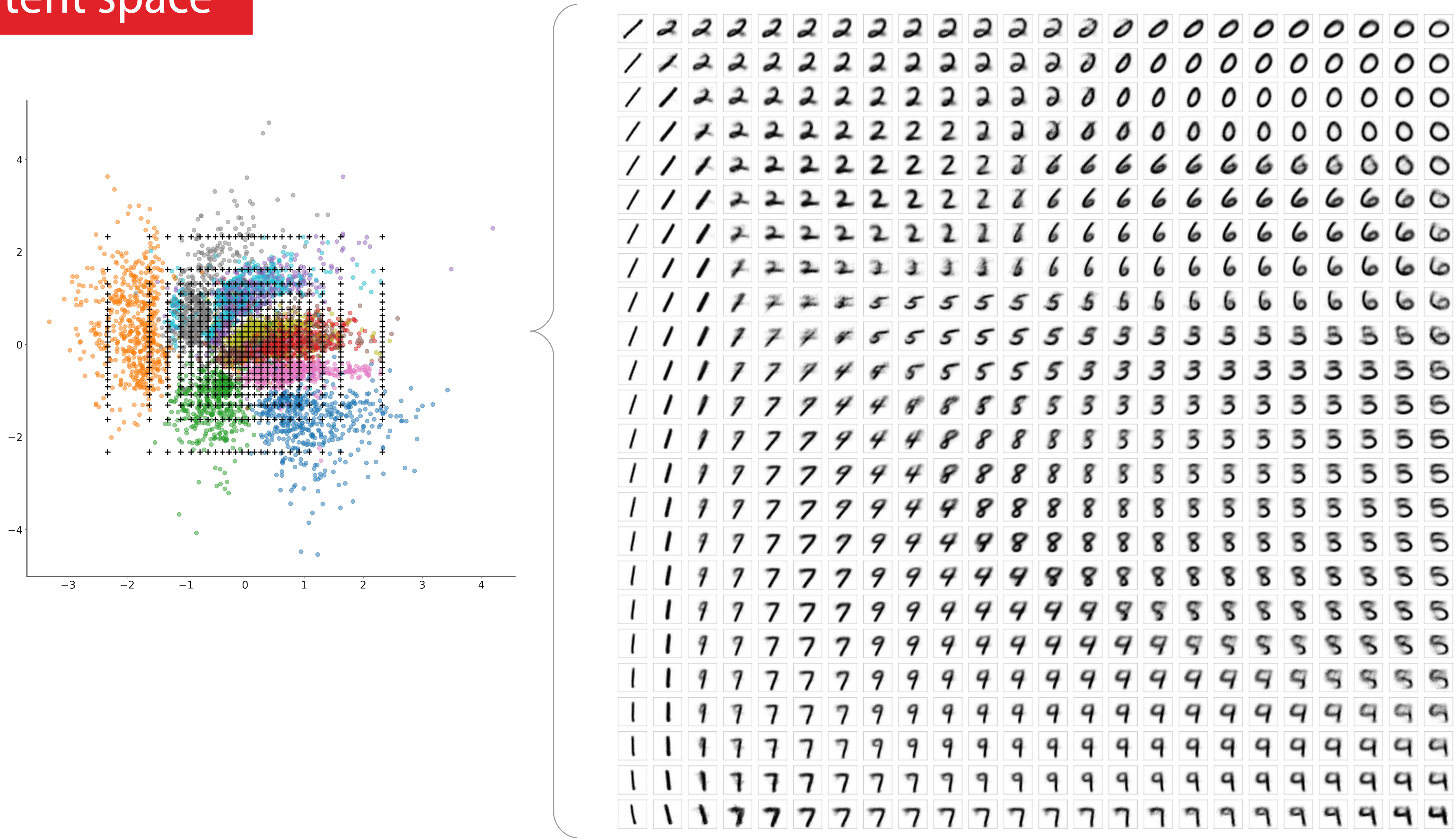


Confused region : « 9 » vs « 4 »

Region of the « 0 »

Region of the « 1 »

Latent space



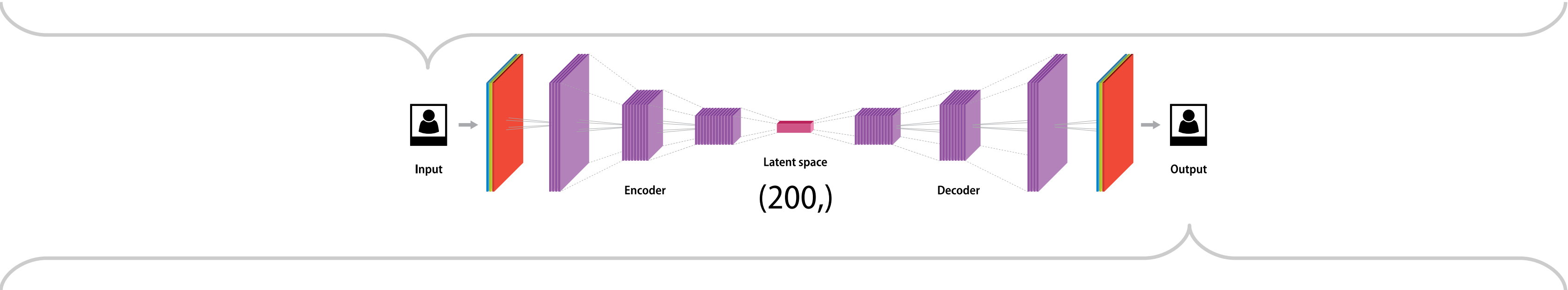
#2

CelebA dataset

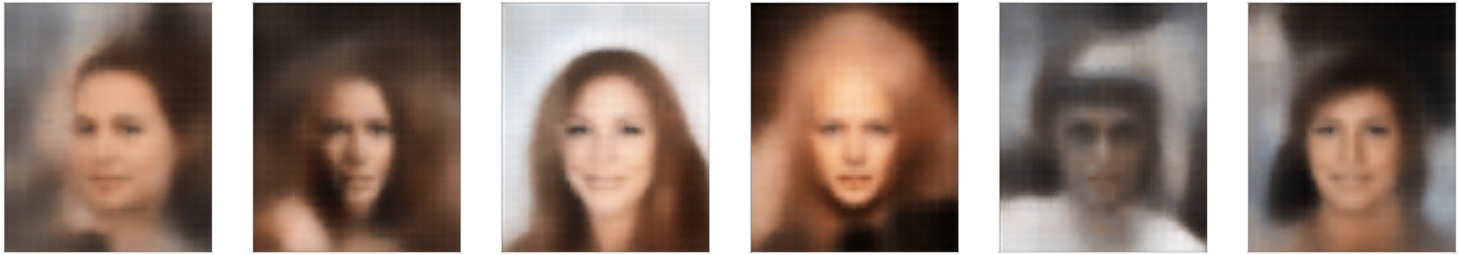
VAE with CelebA

INPUT

192x160



OUTPUT

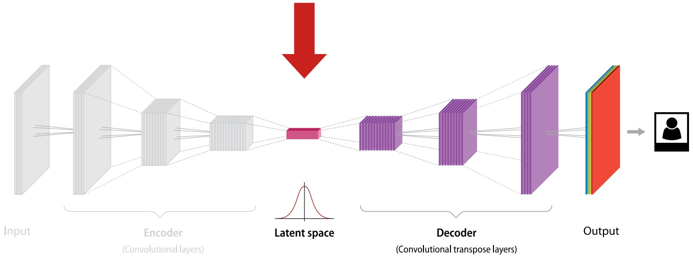


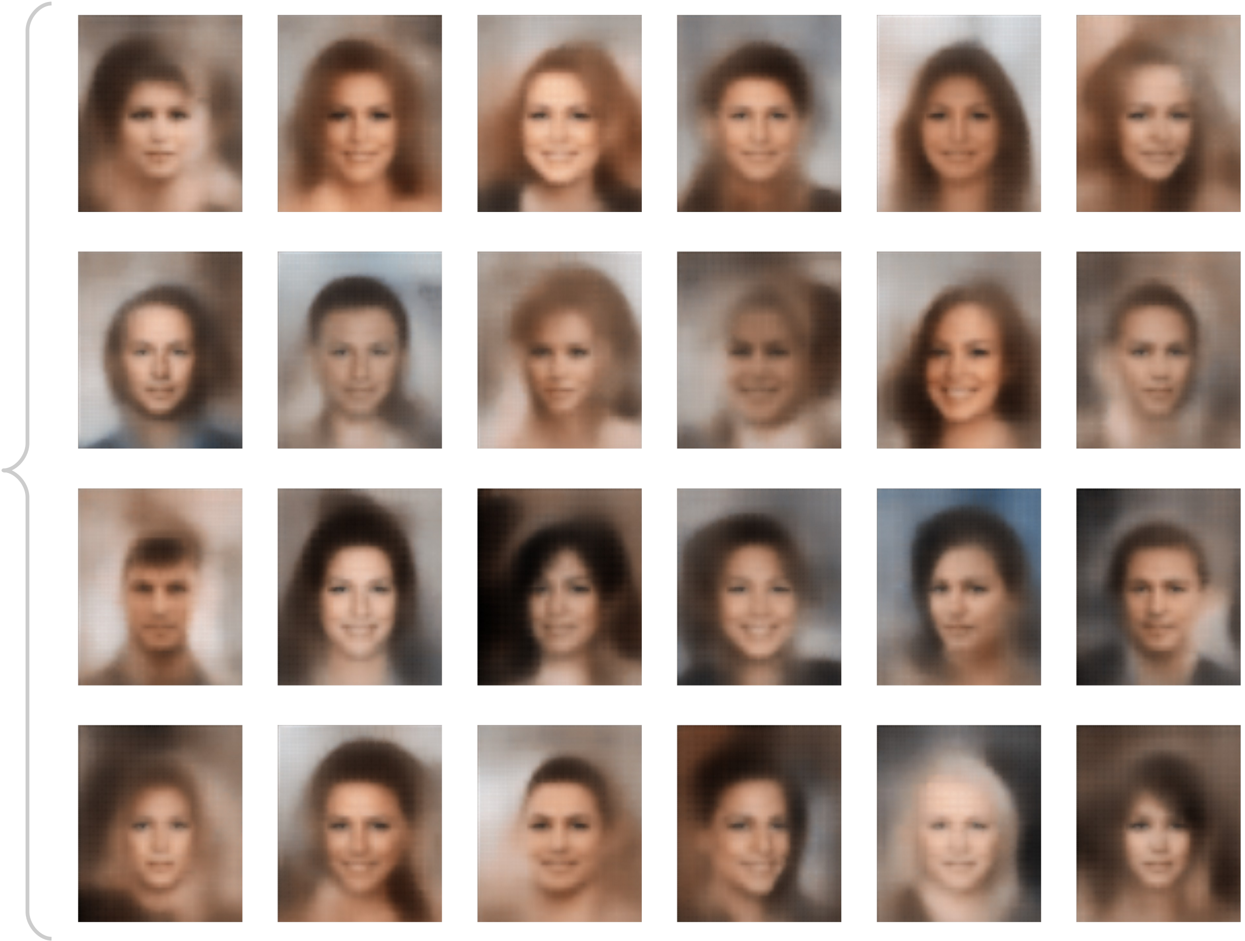
192x160

Dataset : 200.000 images, 192x160x3, 140 GB - Run time : 1h50 on VT100 GPU

Using decoder as a generative network

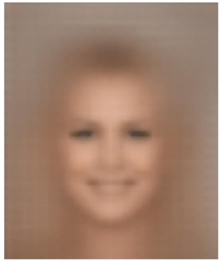
Pick a
Random position
in latent space



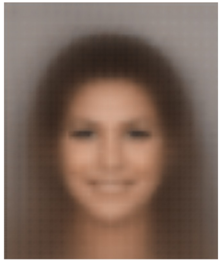


Face generation

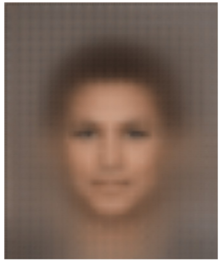
Morphing from latent space



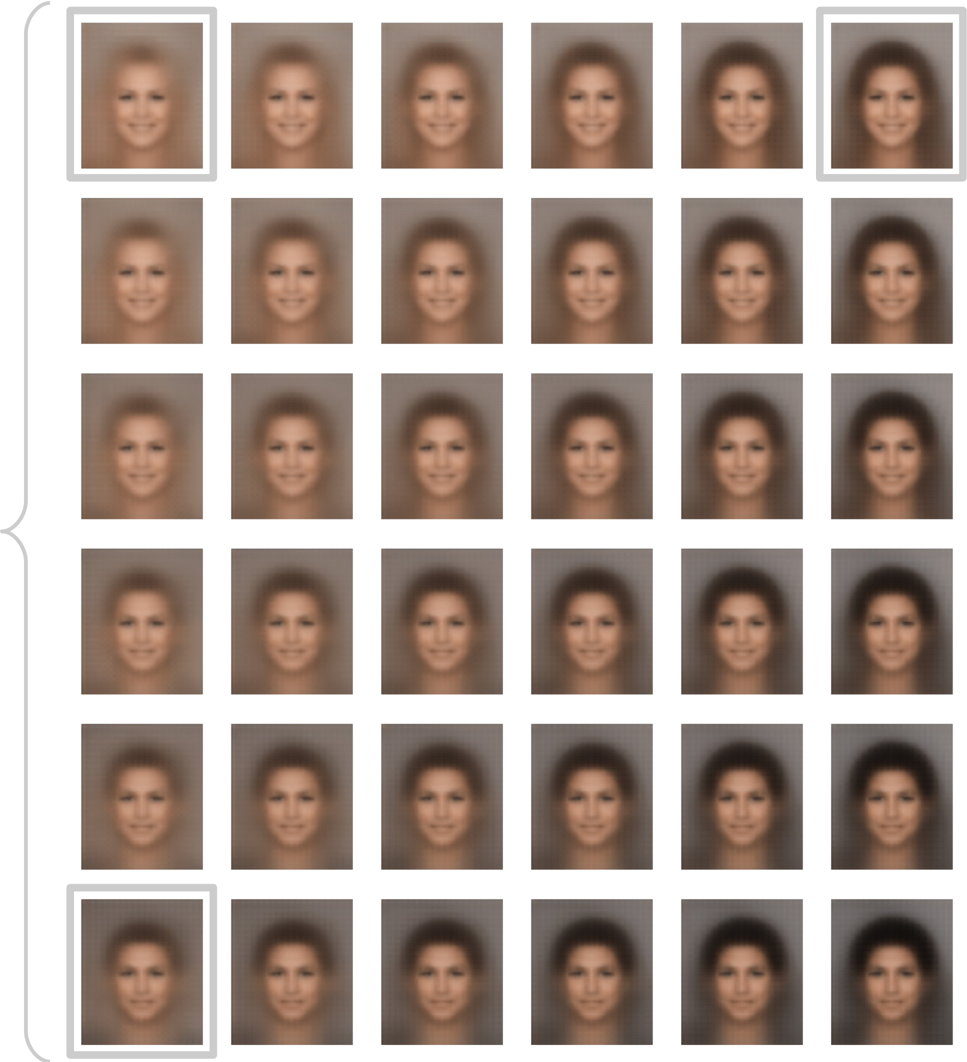
Woman
Blond hair
Smiling



Woman
Black hair
Smiling



Man
Black hair
Not smiling



Variational Autoencoder

Use cases :

Unsupervised classification

Dimension reduction

Data génération

Image Processing (denoising, ...)

Anomaly detection

...

Notebooks and more…

GitLab

https://gricad-gitlab.univ-grenoble-alpes.fr/talks/fidle

http://bit.ly/fidle432

Merci !