



**Machine Learning
Graz**

Generative Adversarial Networks

when neural networks fight each other

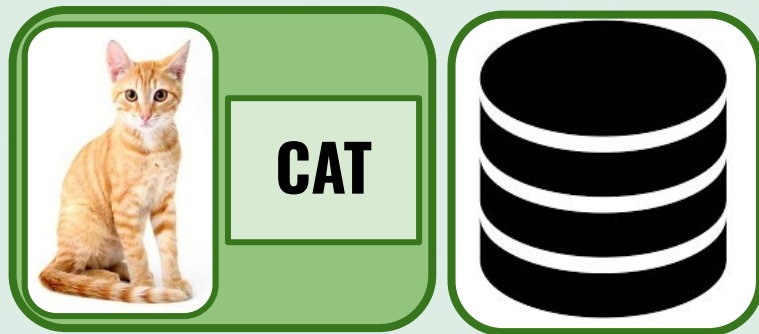
Jules SALZINGER

jules.salzinger@ec-m.fr



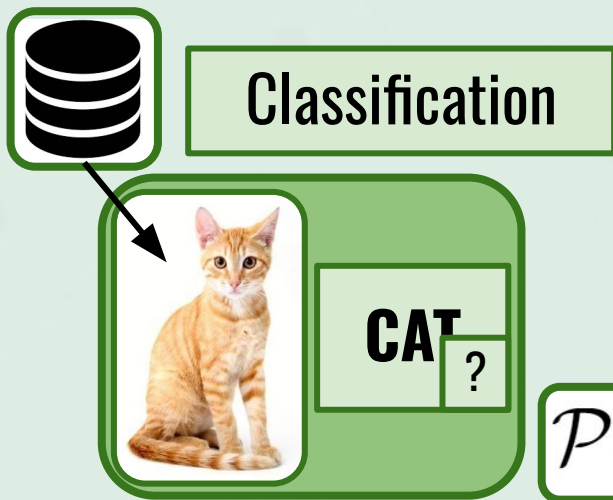
And first of all, maths ! As usual ;)

$$\mathcal{P}(x, y) = \mathcal{P}(x) * \mathcal{P}(y|x)$$

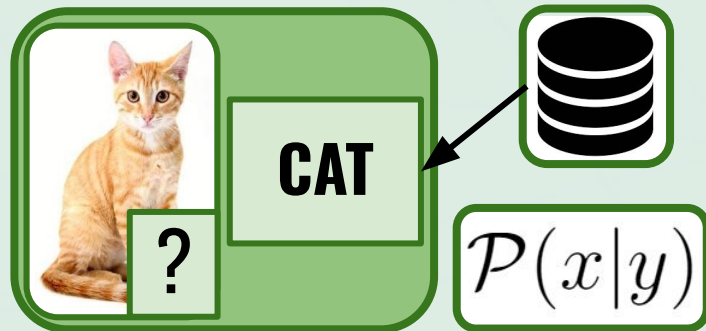


$$\mathcal{P}(x, y)$$

Generation



Classification



CAT

?

$$\mathcal{P}(x|y)$$

Fundamentals

Basic idea

Architecture

A metaphor

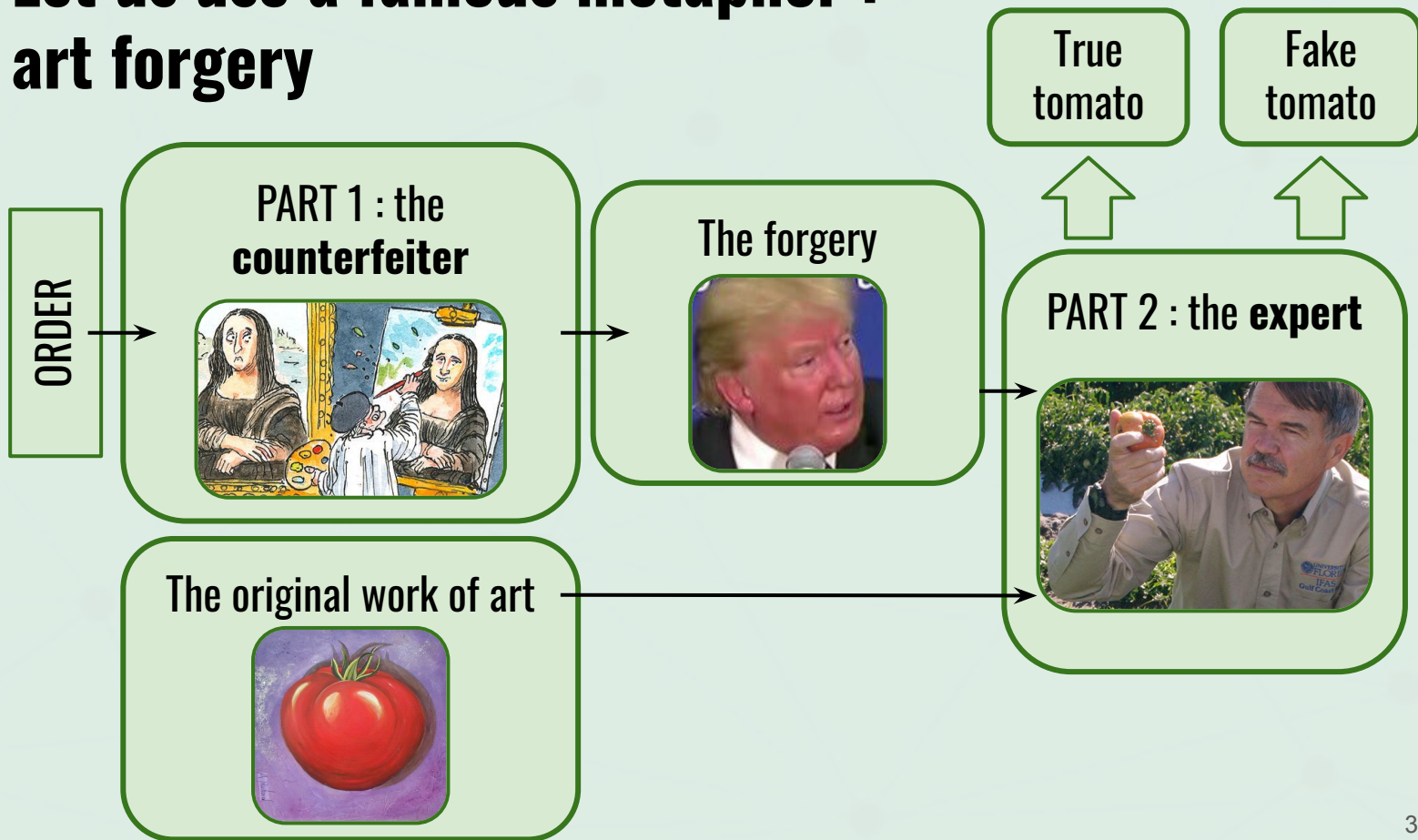
Loss function

Optimization

Common
problems

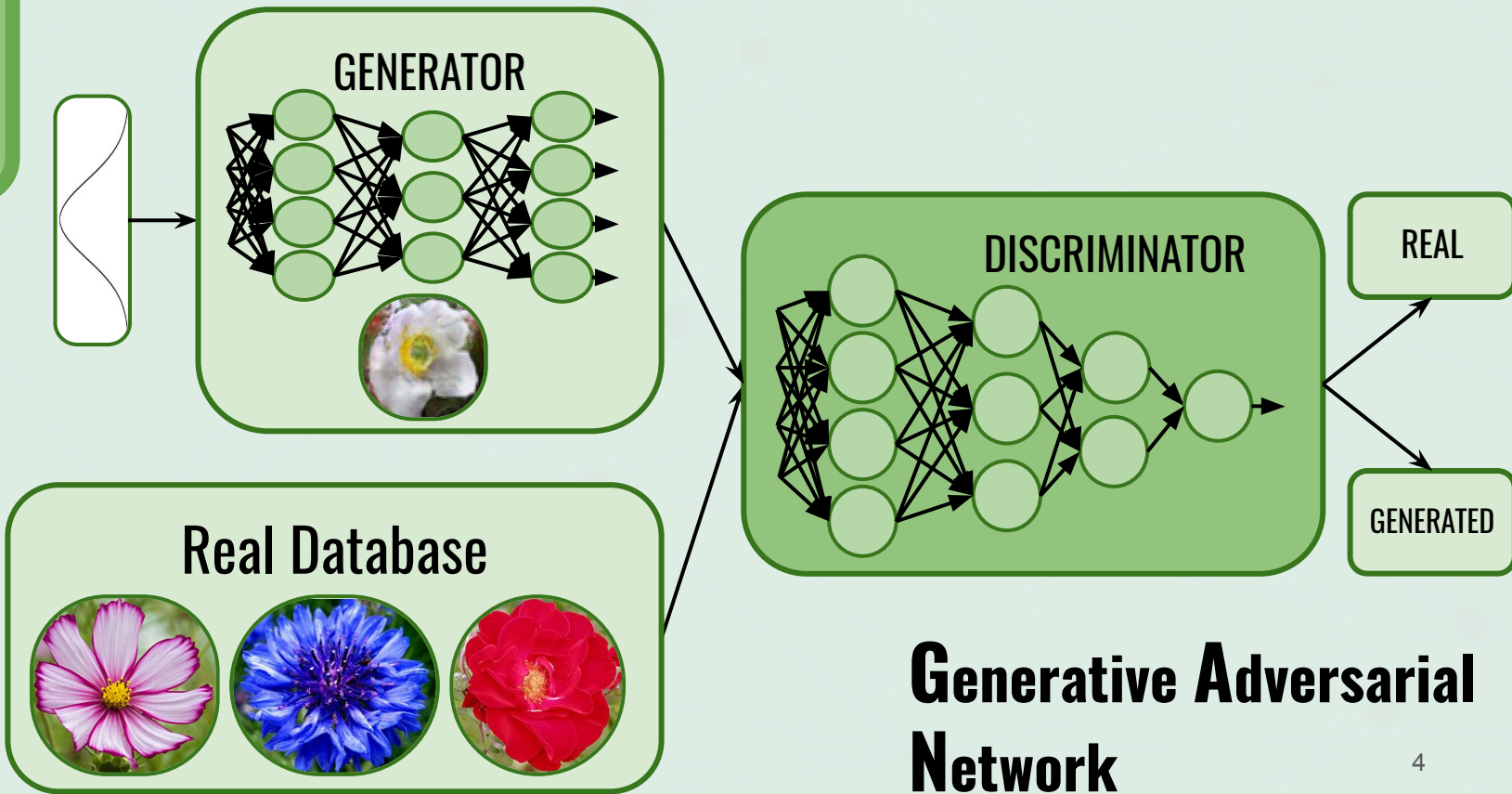


Let us use a famous metaphor : art forgery





This situation is very similar to that of a GAN





Machine
Learning
Graz

Ropes and games



A few interesting notes

the winner does not matter

there can be no progress
if A's and B's strength
are too different

Fundamentals

Basic idea

Architecture

A metaphor

Loss function

Optimization

Common
problems



Interviewing our players

GENERATOR (G)

For any **generated**
sample:

the discriminator should
say it is **real**

$$\mathcal{L}_{gen} = \mathbb{E}_{z \sim p_z(z)} [\log(1 - D(G(z)))]$$



Ian Goodfellow

VS

DISCRIMINATOR (D)

For any **generated**
sample:
the discriminator should
say it is **generated**

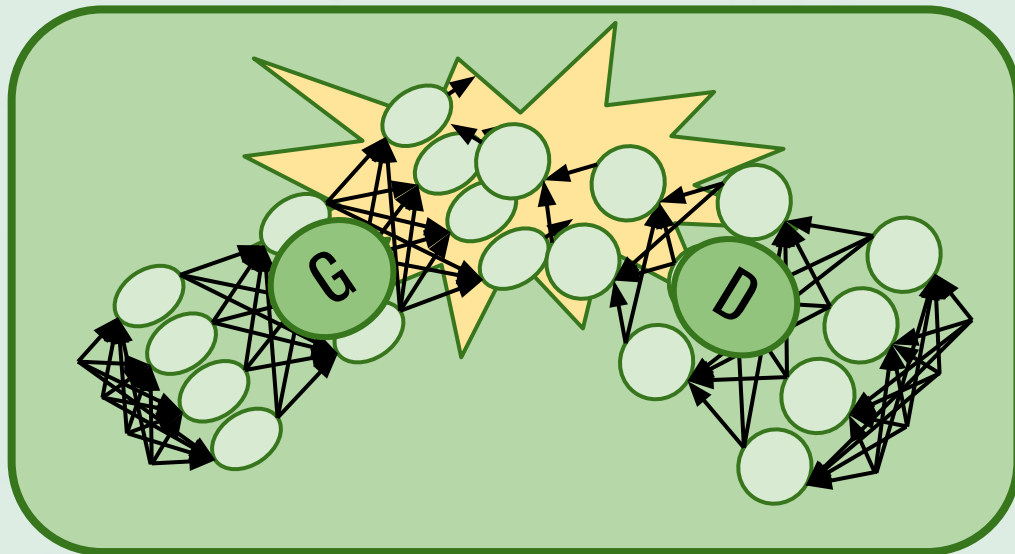
For any sample **from
the database**:

the discriminator should
say it is **real**

$$\mathcal{L}_{disc} = \mathbb{E}_{x \sim p_{data}(x)} [\log(1 - D(x))] \\ + \mathbb{E}_{z \sim p_z(z)} [\log(D(G(z)))]$$



**And finally...
the game !**



G

D

$$\mathcal{L}_{GAN} = \mathbb{E}_{x \sim p_{data}(x)} [\log(D(x))] \\ + \mathbb{E}_{z \sim p_z(z)} [\log(1 - D(G(z)))]$$

$$\min_G \max_D \mathcal{L}_{GAN}(G, D)$$

Fundamentals

Basic idea

Architecture

A metaphor

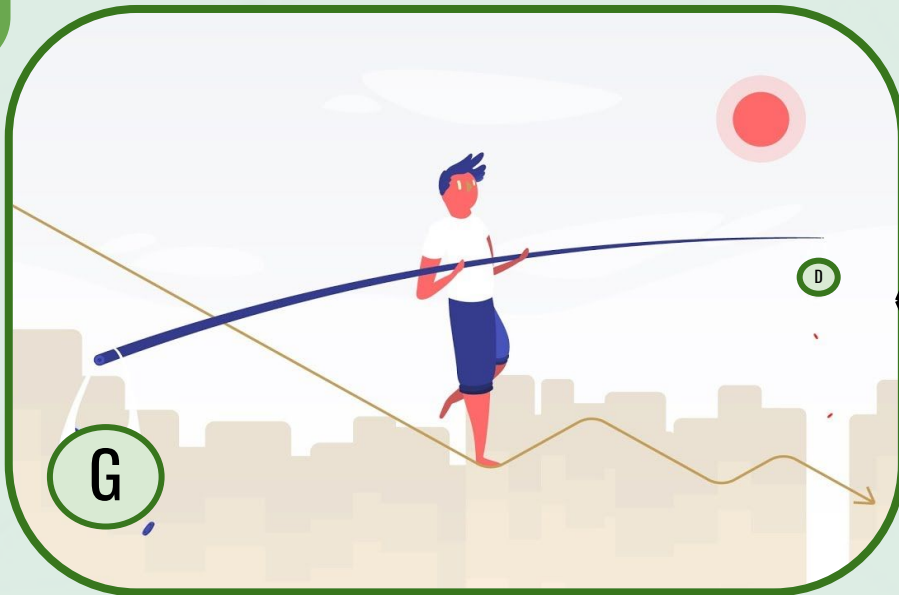
Loss function

Optimization

Common
problems



Welcome to the world of GANs ! A world... of pain and suffering :)



Generator is too fast ?
You lose...

Discriminator too fast ?
You lose as well...

Same speed ?
Well sometimes... you lose anyway !

Fundamentals

Basic idea

Architecture

A metaphor

Loss function

Optimization

Common
problems



Machine
Learning
Graz

It's official : we're in trouble

The gradients disappear...
ALL the time....



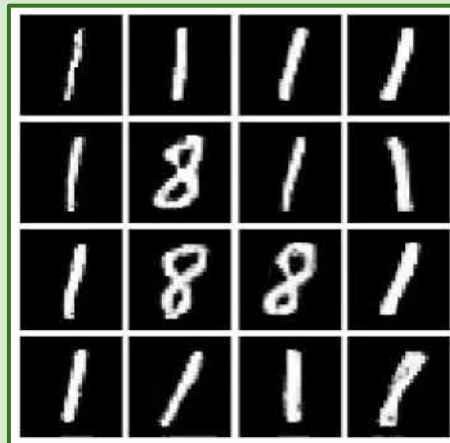
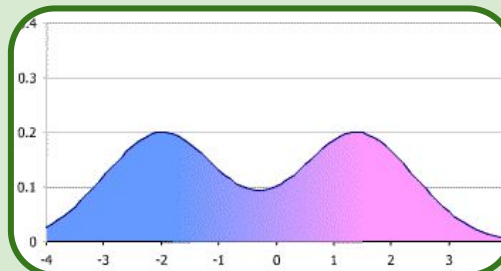
INFORMATION

Generator

Discriminator

GRADIENTS

Mode collapsing problems



Fundamentals

Basic idea

Architecture

A metaphor

Loss function

Optimization

Common
problems



Machine
Learning
Graz

Thank you for your attention !

Questions, suggestions, comments, criticisms... ? I love them all ! ⇒ jules.salzinger@ec-m.fr

Source materials and additional info:

GAN original paper: <https://arxiv.org/abs/1406.2661>

GAN tutorial: <https://arxiv.org/abs/1701.00160>

<https://www.reactivereality.com/>



grasmug@reactivereality.com