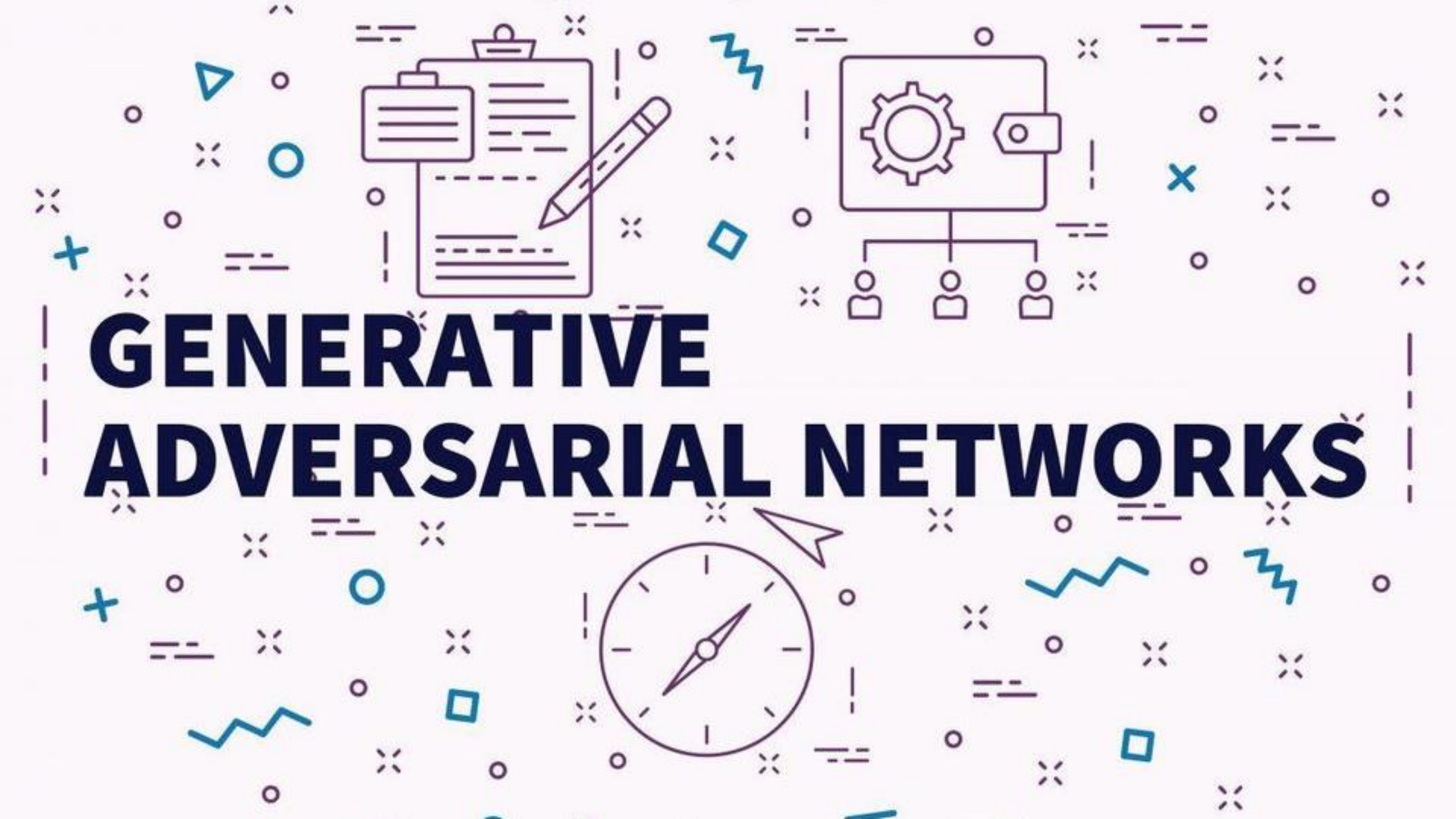
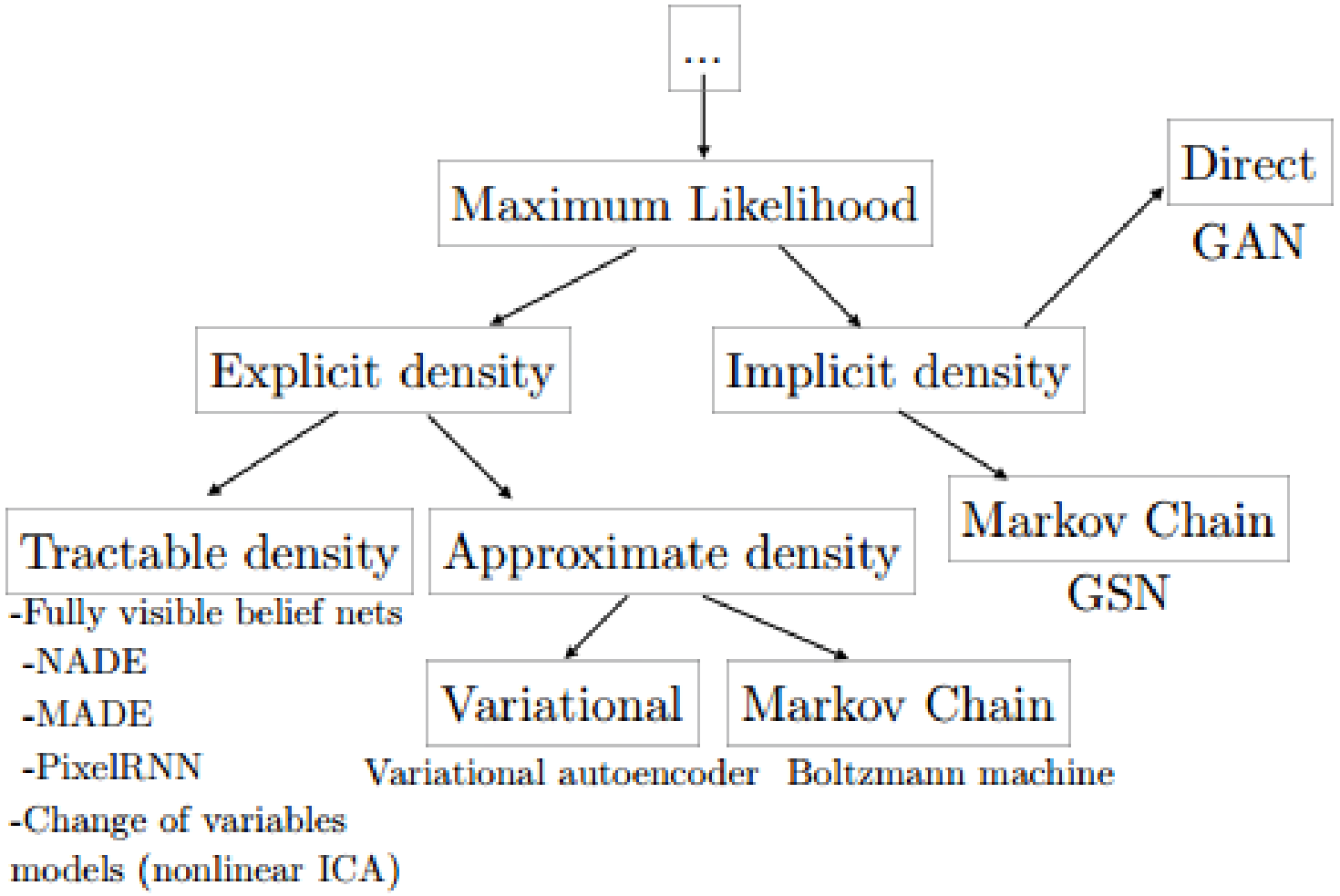
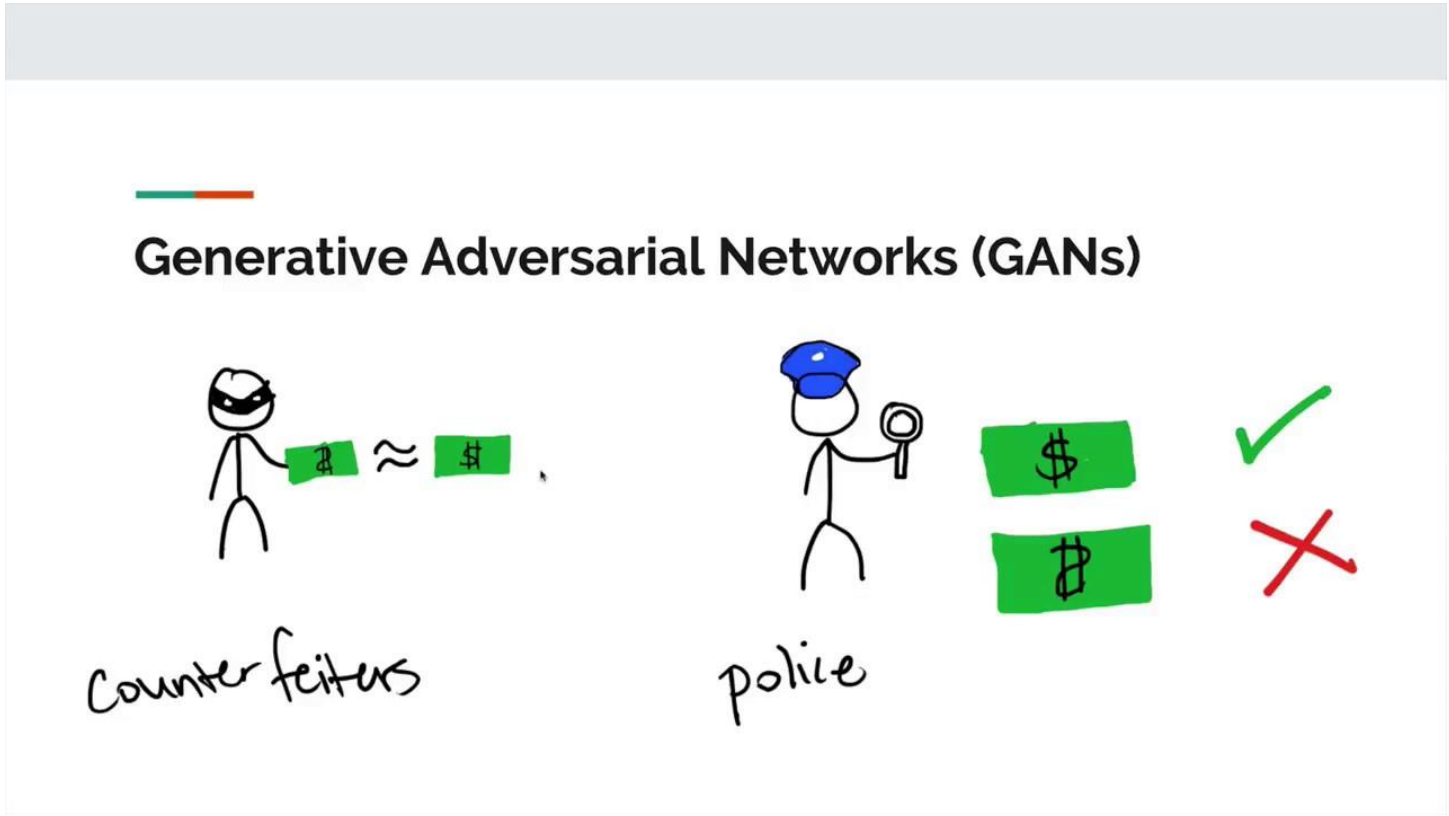

GENERATIVE
ADVERSARIAL NETWORKS

Why GANs had been invented?



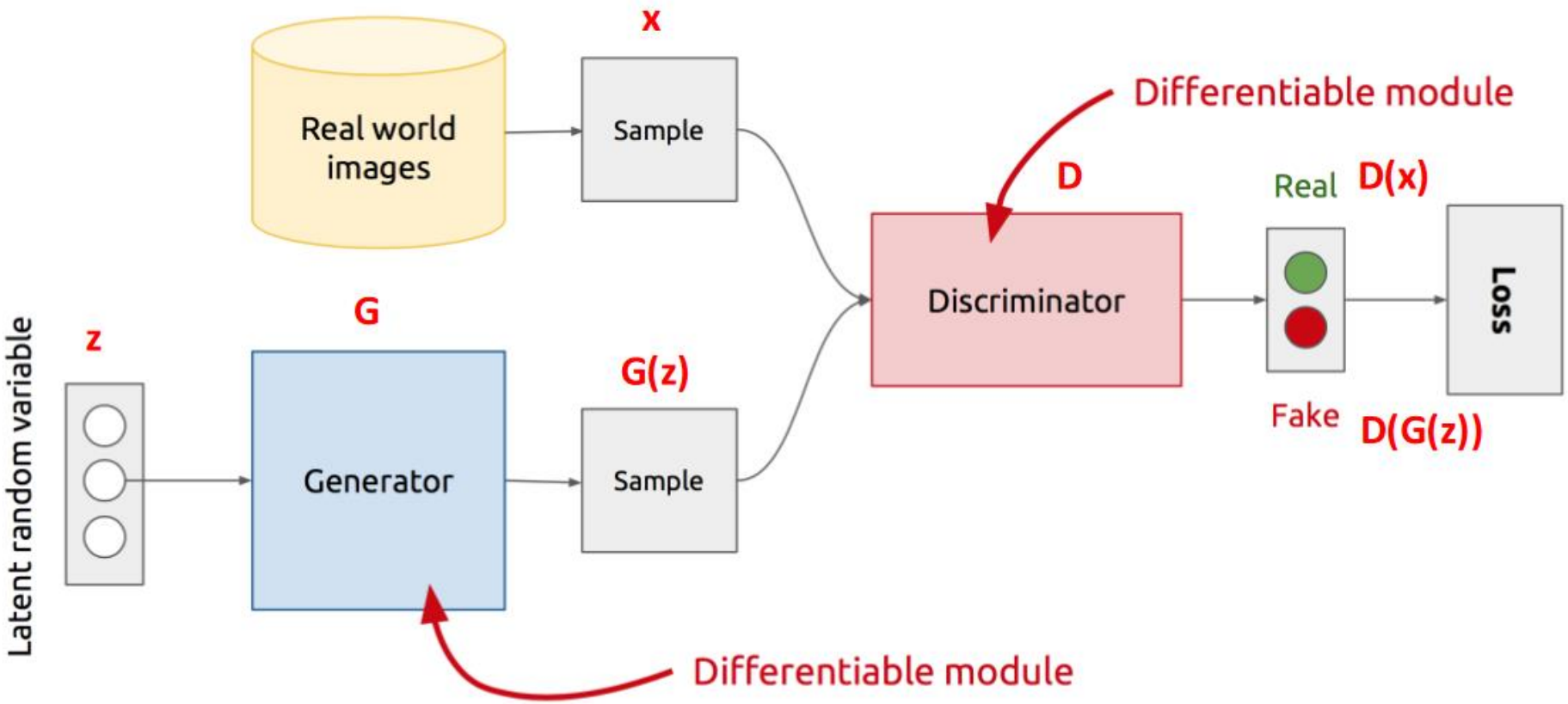
Taxonomy of Generative Models (from Ian Goodfellow's NIPS tutorial, 2016)

Graph depicts the various families of generative models as described by Ian Goodfellow in his NIPS tutorial.

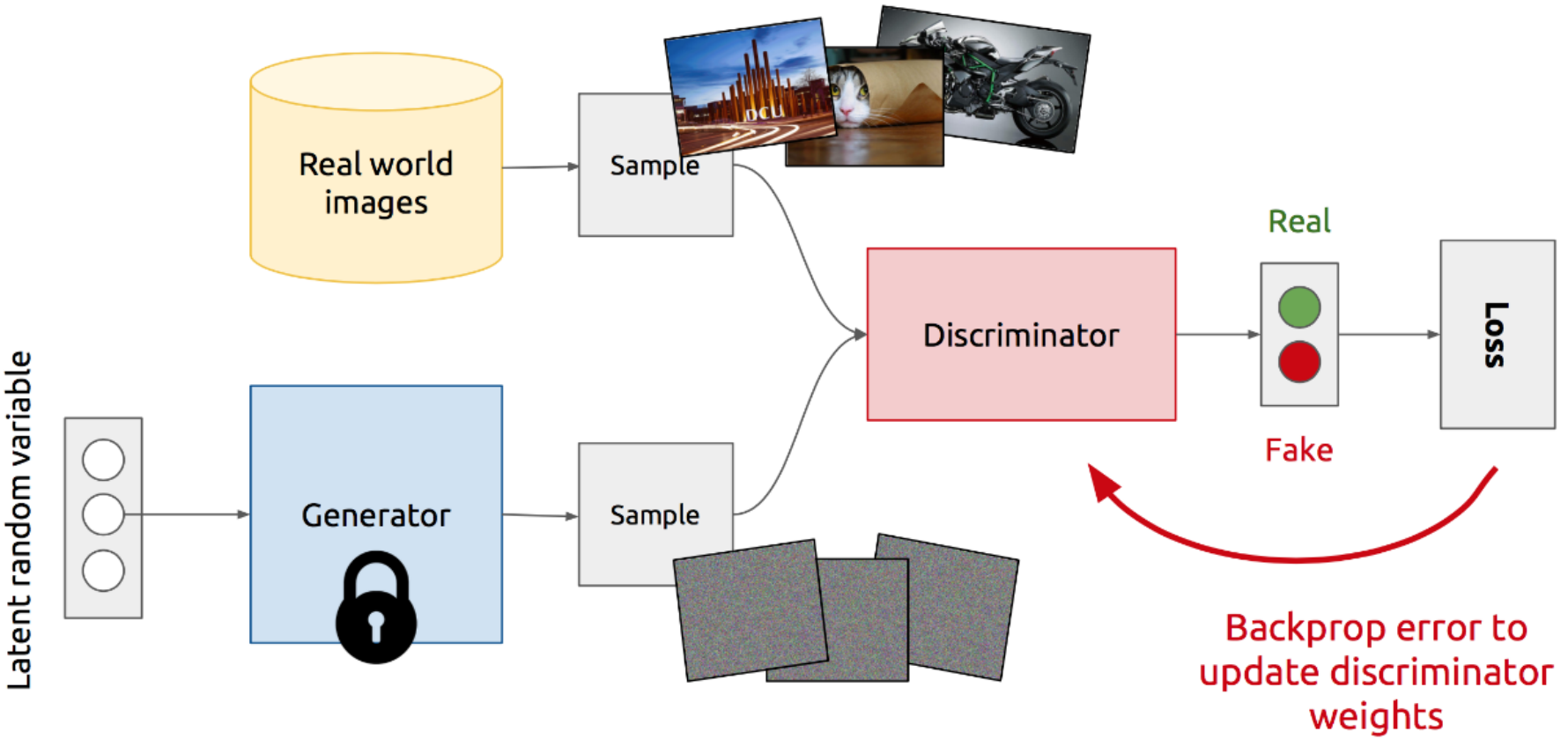

Generative Adversarial Networks (GANs)
counterfeiters
police

Intuition

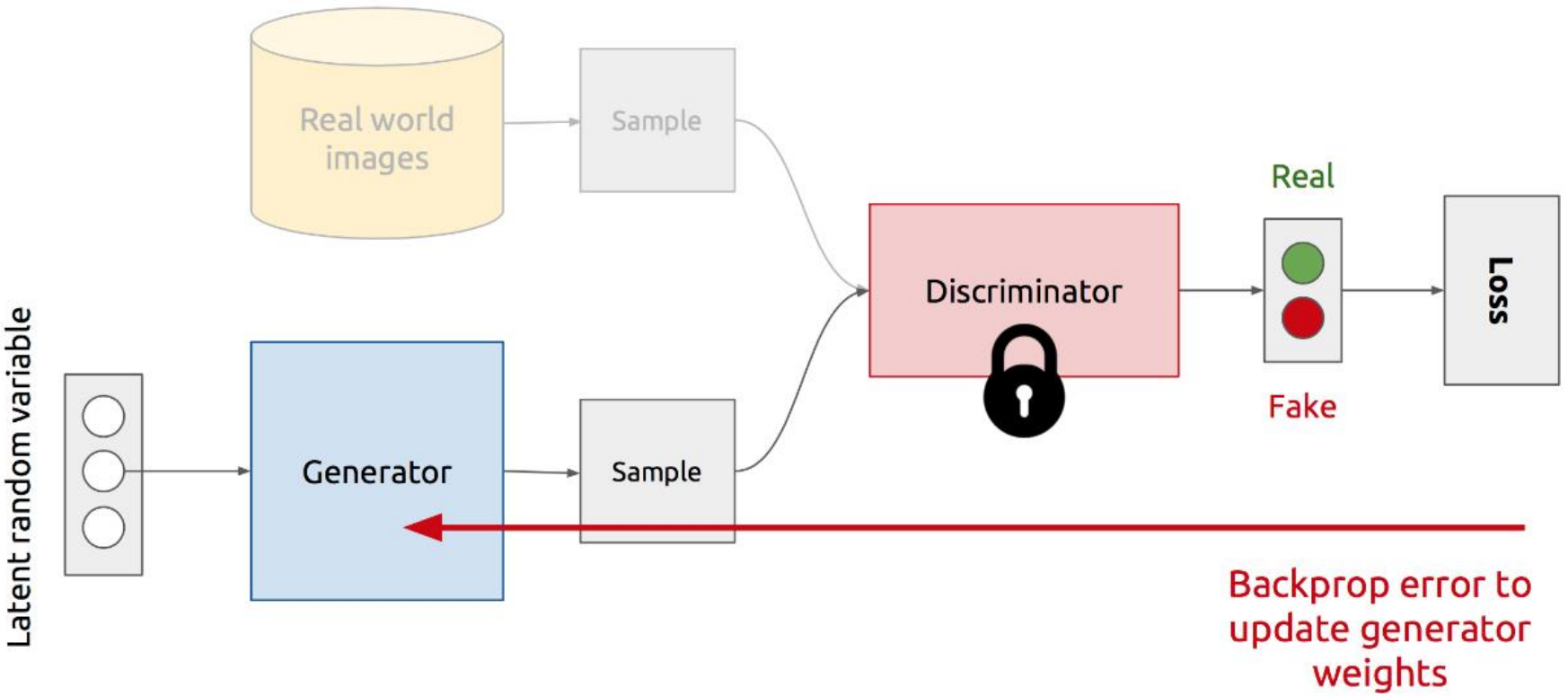
The idea of GANs



Training Discriminator



Training Generator



GANs formula

It is formulated as a minimax game, where:

- The Discriminator is trying to maximize its reward $\boldsymbol{V(D,G)}$
- The Generator is trying to minimize Discriminator's reward (or maximize its loss)

$$\min_G \max_D V(D,G) = \mathbb{E}_{\boldsymbol{x}\sim p_{\text{data}}(\boldsymbol{x})}[\log D(\boldsymbol{x})] + \mathbb{E}_{\boldsymbol{z}\sim p_{\boldsymbol{z}}(\boldsymbol{z})}[\log(1 - D(G(\boldsymbol{z})))].$$

Some theorem

Firstly, authors consider the optimal discriminator D for any given generator G.

$$D_G^*(\boldsymbol{x}) = \frac{p_{data}(\boldsymbol{x})}{p_{data}(\boldsymbol{x}) + p_g(\boldsymbol{x})}$$

Nextly, they found minimum:

The global minimum of the virtual training criterion $C(G)$ is achieved if and only if $p_g = p_{data}$. At that point, $C(G)$ achieves the value $-\log 4$.

Finally, they proved that:

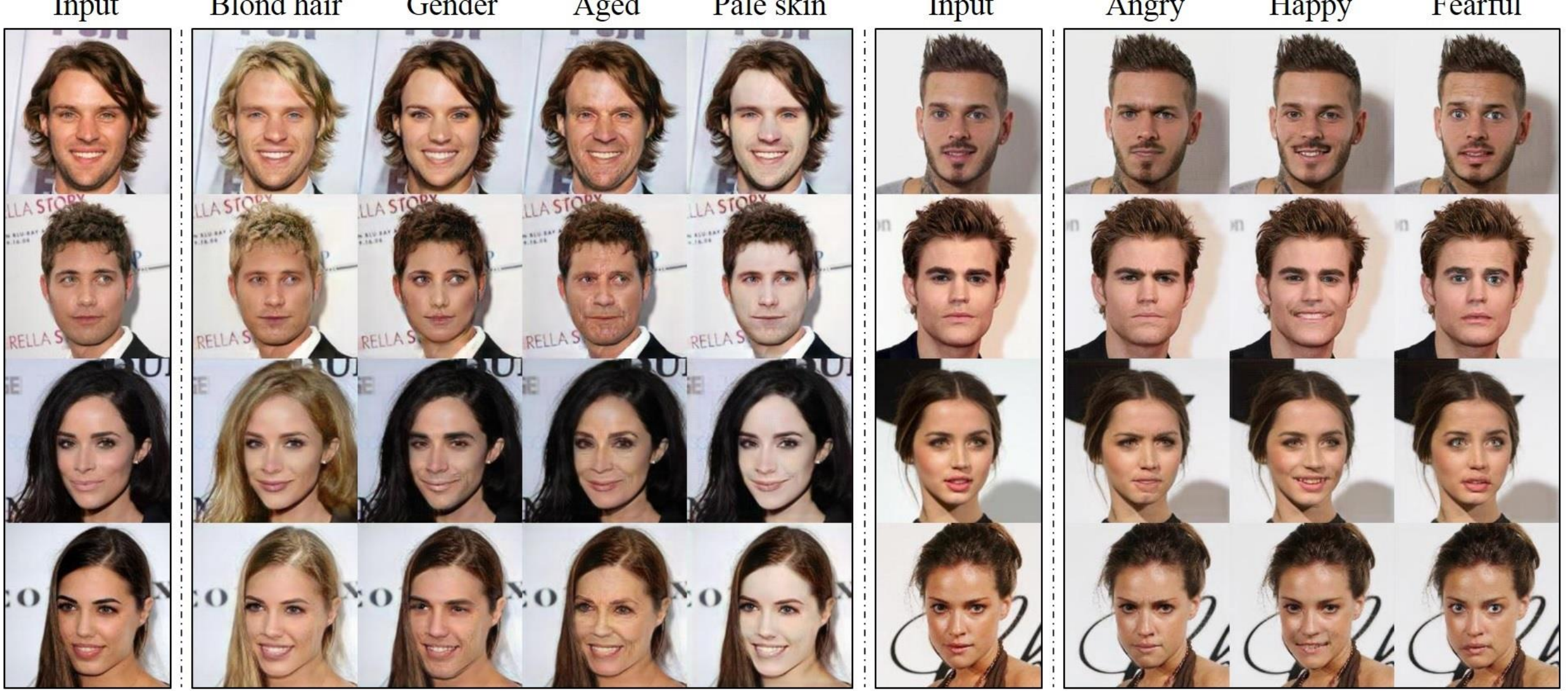
Proposition 2. *If G and D have enough capacity, and at each step of Algorithm 1, the discriminator is allowed to reach its optimum given G, and p_g is updated so as to improve the criterion*

$$\mathbb{E}_{\boldsymbol{x}\sim p_{data}}[\log D_G^*(\boldsymbol{x})] + \mathbb{E}_{\boldsymbol{x}\sim p_g}[\log(1 - D_G^*(\boldsymbol{x}))]$$

then p_g converges to p_{data}

Pros and cons

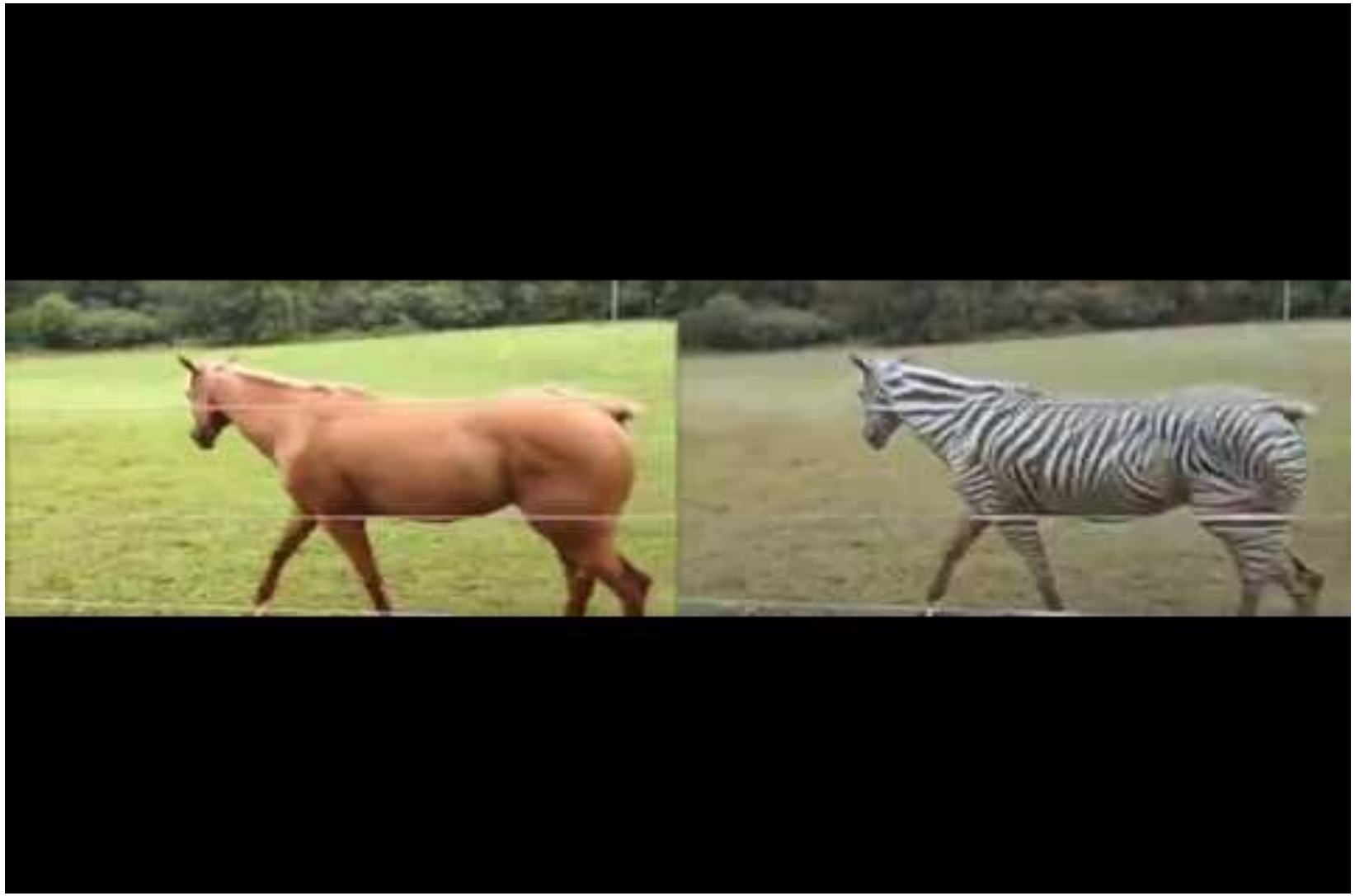
Some examples


Input
Blond hair
Gender
Aged
Pale skin
Input
Angry
Happy
Fearful

StarGAN

Art with GAN

CycleGAN



Fake videos

GAUGAN – Nvidia project

GauGAN

Thanks for your attention!

- Dominik Jaźwiecki
- Michał Kubica