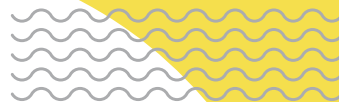




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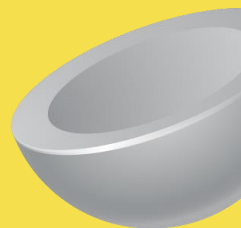
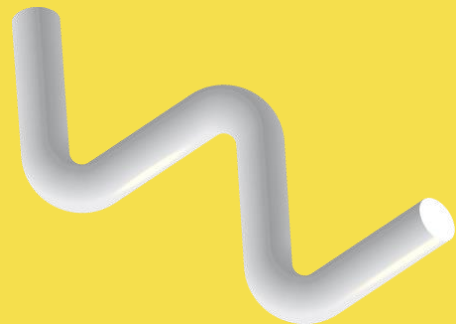


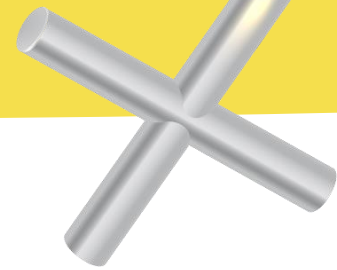
Programarea Aplicațiilor de Simulare

Rețele Generative Adversariale

Curs 3

Pătrânjel David-George





Agenda Cursului

01

**Rețele Generative
Adversariale**

02

**Antrenarea
Rețelelor GAN**

03

Arhitecturi GAN

04

Aplicații





01

Rețele Generative Adversariale



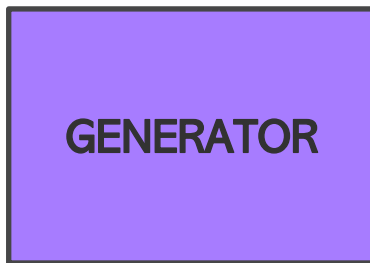
Introducere

- **GANs: Rețele Generative Adversariale**
- **Arhitectură propusă în 2014** de Ian Goodfellow et al. în lucrarea *"Generative Adversarial Nets"*.
- Rețea neuronală ce stă la baza Inteligenței Artificiale Generative.
- Utile în generarea de conținut nou, diferit de setul de date utilizat în procesul de antrenare.
- Aplicații în procesarea și generarea de imagini, texte, conținut video, sunet (muzică, voce etc.).
- **Are la bază o antrenare competitivă între un Generator și un Discriminator!**

Arhitectura GAN

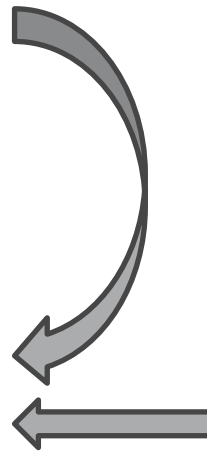
GENERATOR

Generează conținut nou



DISCRIMINATOR

Discerne între imagini generate și imagini reale

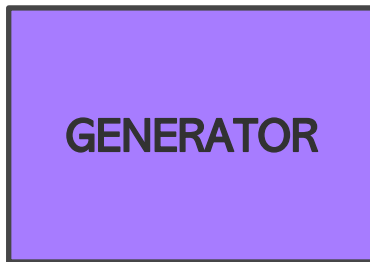


SET DE DATE

Generatorul

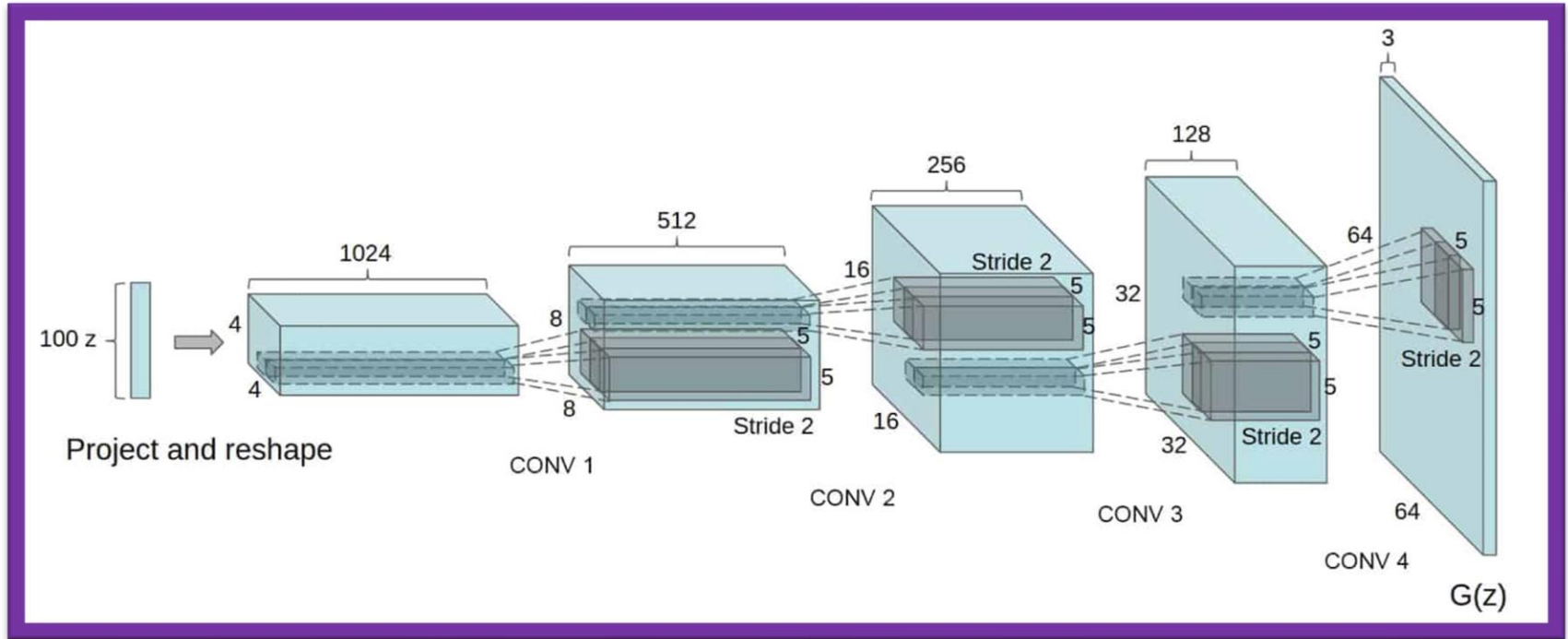
GENERATOR (G)

Generează conținut nou



- Pornind de la spațiul latent Z , **G** învață distribuția datelor reale $P(X)$ pentru a genera imagini cu distribuția $P'(X)$.
- Spațiul latent este supra-eșantionat prin utilizarea straturilor convoluționale (rețele CNN) pentru a obține o imagine.
- **G** nu are acces la datele reale!

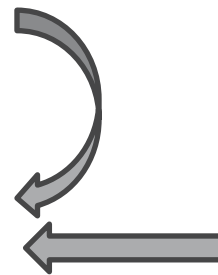
Generatorul



Discriminatorul

DISCRIMINATOR

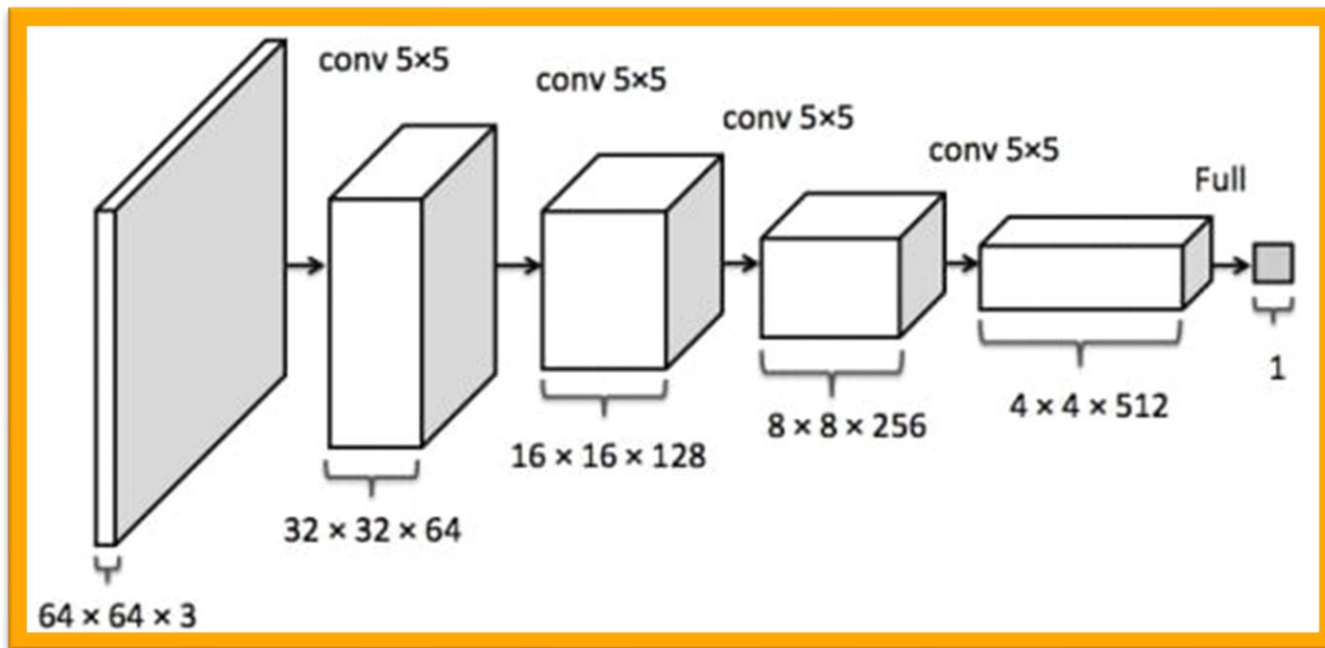
Discerne între imagini generate și imagini reale



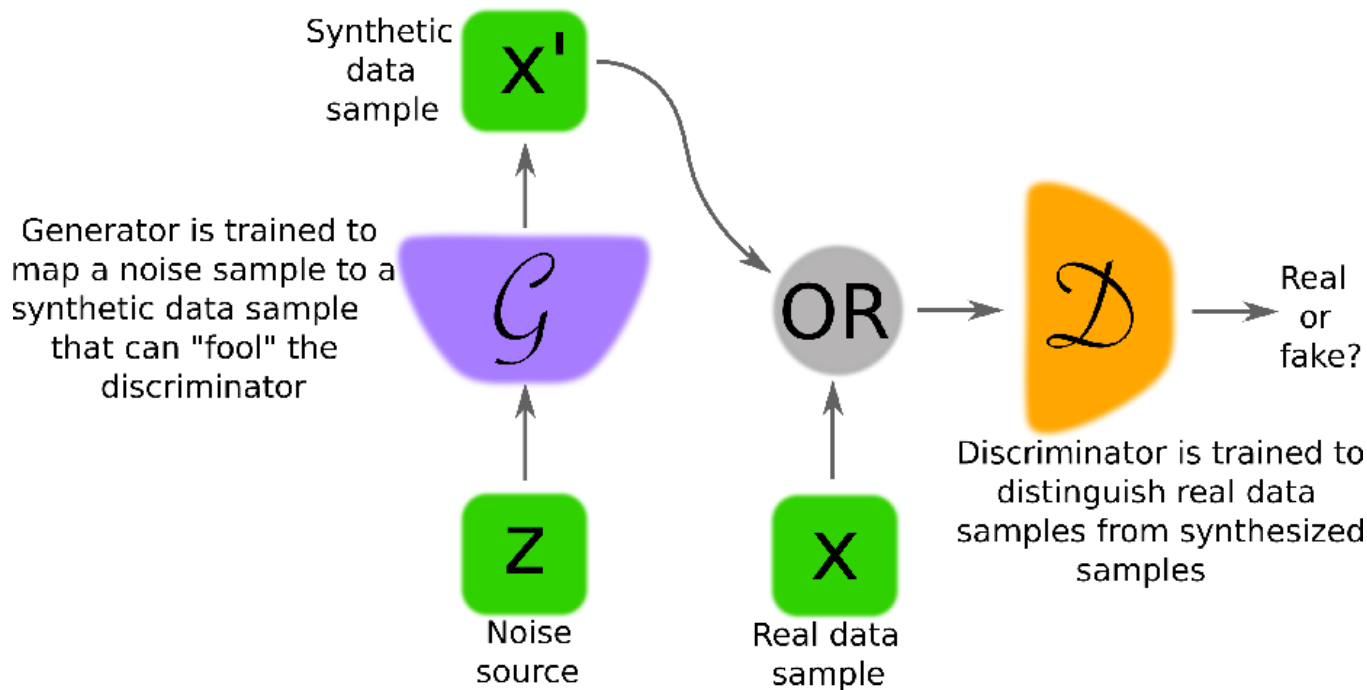
SET DE DATE

- Pornind de la imagini (reale sau generate), **D** învață să distingă între imaginile reale și generate.
- Imaginile sunt sub-eșantionate prin utilizarea straturilor convoluționale (rețele CNN) pentru a obține în final o valoare de 0 sau 1 (real/generat).
- **D** are o arhitectură tipică unui clasificator binar.

Discriminatorul

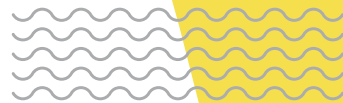
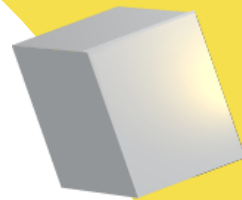


Flow-ul unui GAN



02

Antrenarea Rețelelor GAN



Algoritmul de antrenare

for number of training iterations **do**

for k steps **do**

- Sample minibatch of m noise samples $\{z^{(1)}, \dots, z^{(m)}\}$ from noise prior $p_g(z)$.
- Sample minibatch of m examples $\{x^{(1)}, \dots, x^{(m)}\}$ from data generating distribution $p_{\text{data}}(x)$.
- Update the discriminator by ascending its stochastic gradient:

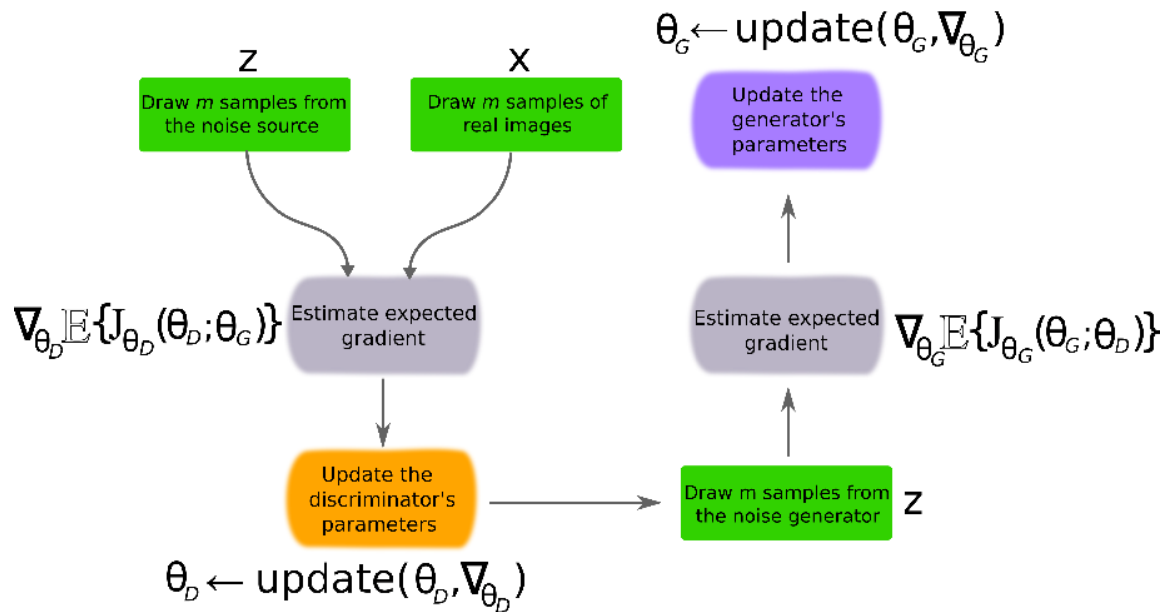
$$\nabla_{\theta_d} \frac{1}{m} \sum_{i=1}^m \left[\log D(x^{(i)}) + \log \left(1 - D(G(z^{(i)})) \right) \right].$$

end for

- Sample minibatch of m noise samples $\{z^{(1)}, \dots, z^{(m)}\}$ from noise prior $p_g(z)$.
- Update the generator by descending its stochastic gradient:

$$\nabla_{\theta_g} \frac{1}{m} \sum_{i=1}^m \log \left(1 - D(G(z^{(i)})) \right).$$

Antrenare MinMax - GAN

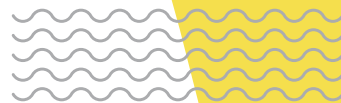
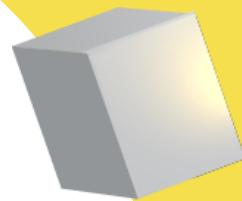


$$\min_G \max_D \left[\mathbb{E}_{(X \sim P(X))} [\log D(X)] + \mathbb{E}_{(Z \sim P(Z))} [\log (1 - D(G(Z)))] \right]$$

Full proof

03

Arhitecturi GAN

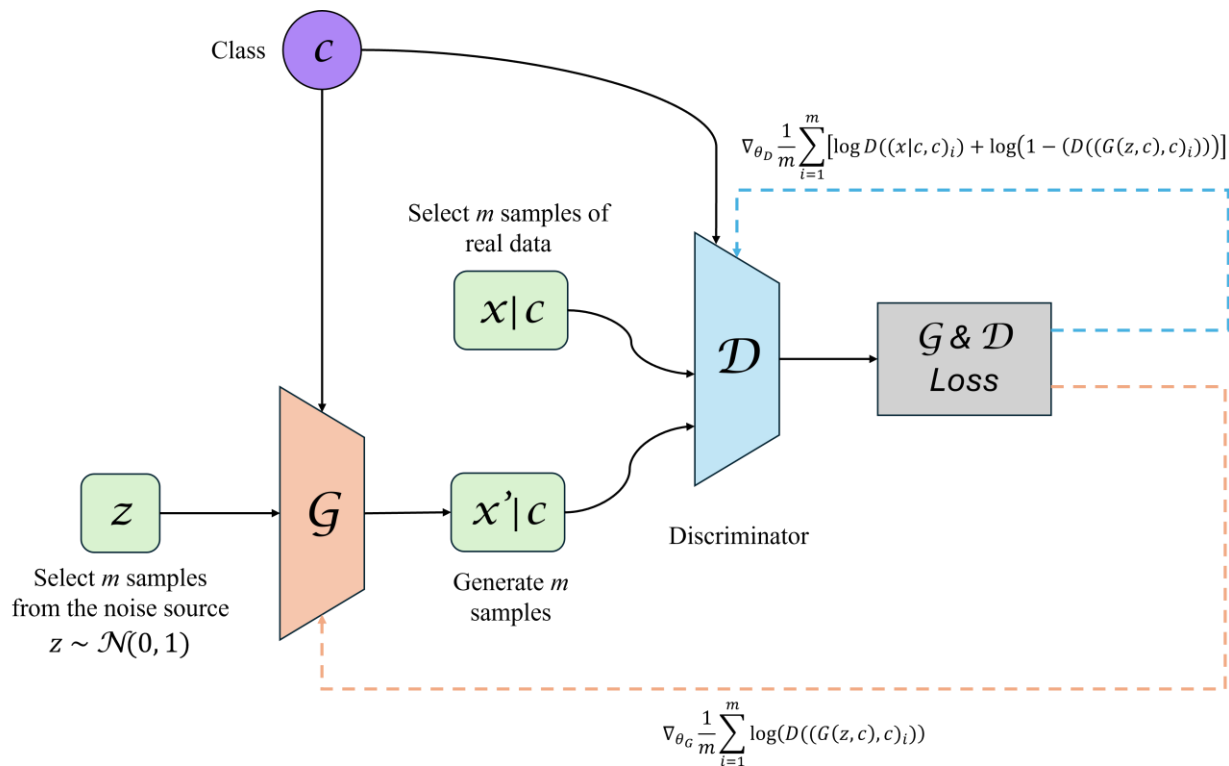




1. Rețele Generative Adversariale Condiționate (cGAN)

- Arhitectură propusă în 2014 în lucrarea *"Conditional Generative Adversarial Nets"*.
- Permite generarea imaginilor pe baza unei **etichete sau condiții suplimentare** (set de date adnotat).
- Introducerea unei condiții suplimentare mărește controlul asupra rezultatelor obținute, având astfel un generator specializat.

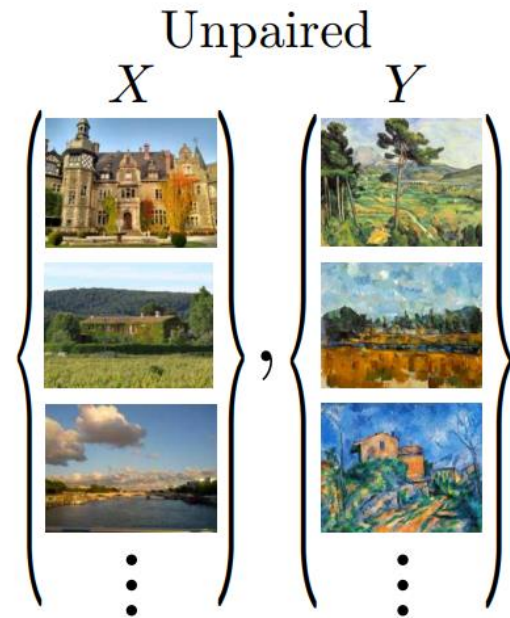




Antrenarea cGAN

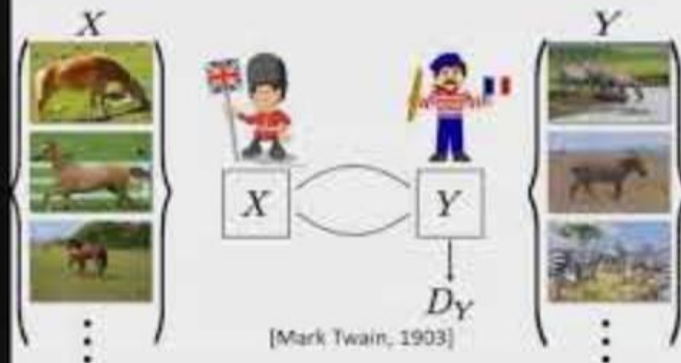
2. Rețele Generative Adversariale Ciclice (CycleGAN)

- Arhitectură propusă în 2017 în lucrarea "*Unpaired Image-to-Image Translation using Cycle-Consistent Adversarial Networks*".
- Permite transformarea imaginilor dintr-un set X la un set Y fără a necesita perechi de imagini în procesul de antrenare.
- Arhitectura CycleGAN asigura transformarea unei imagini în ambele sensuri ($X \rightarrow Y \rightarrow X$).





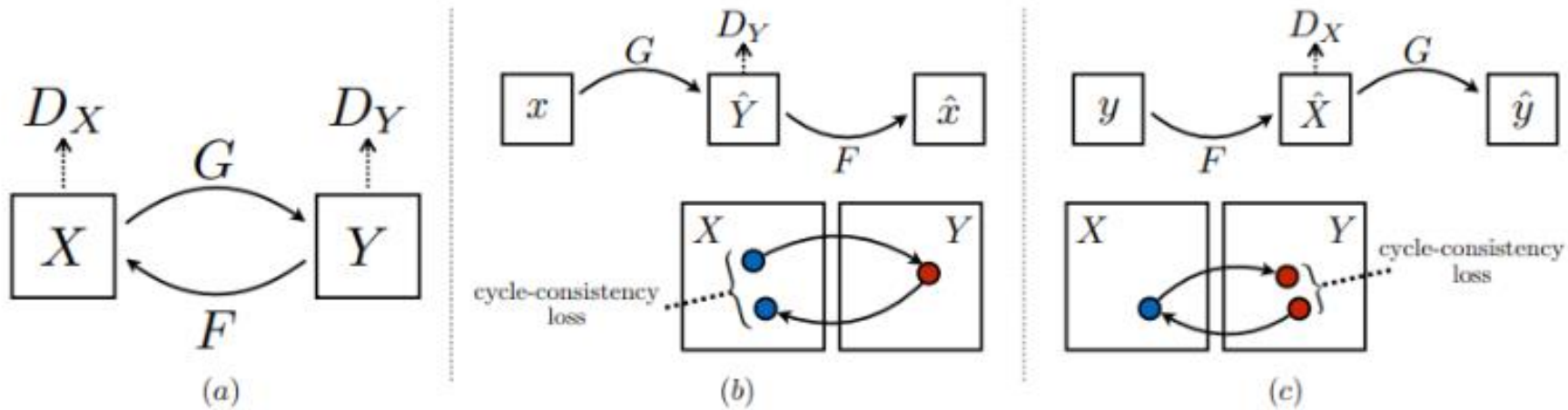
Cycle-Consistent Adversarial Networks



ICCV T7

CycleGAN

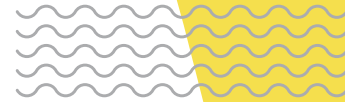
<https://junyanz.github.io/CycleGAN/>



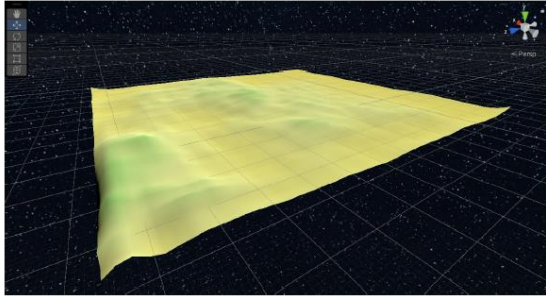
Antrenarea CycleGAN

04

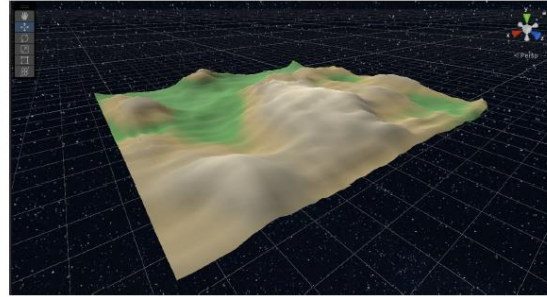
Aplicații



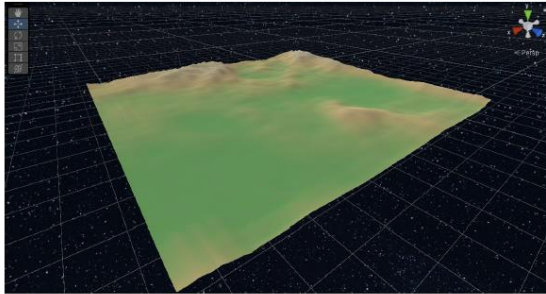
Generarea Procedurală de Teren Condiționat (cGAN)



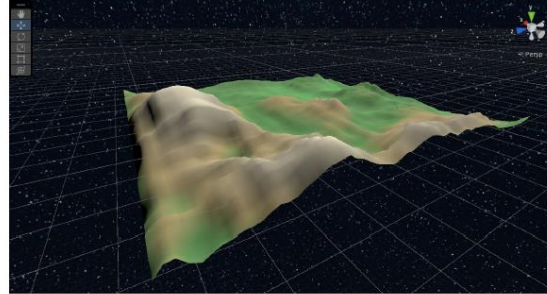
(a) *Desert*



(b) *Valley*

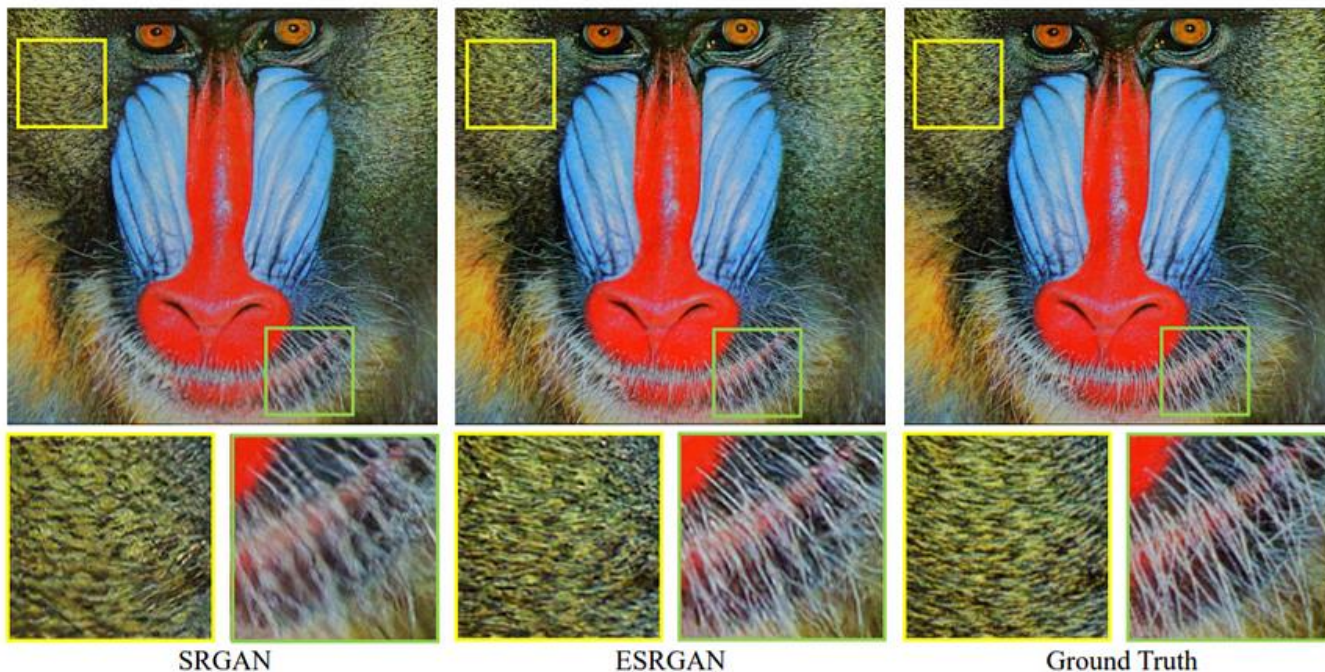


(c) *Plain*



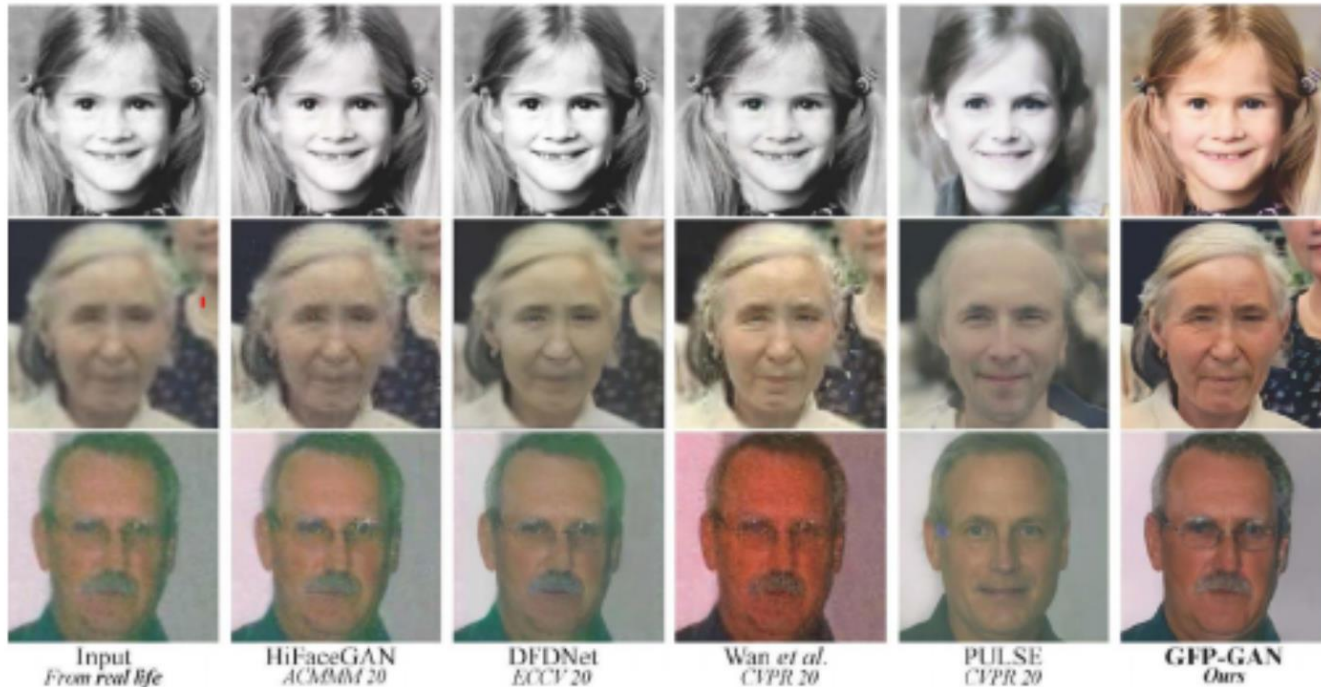
(d) *Mountain*

Super Rezoluție



V. Sinha, "ESRGAN : Enhanced Super Resolution GAN - Analytics Vidhya - Medium," Medium, Dec. 14, 2021. [Online]. Available: <https://medium.com/analytics-vidhya/esrgan-enhanced-super-resolution-gan-96a28821634>

Restaurarea imaginilor vechi



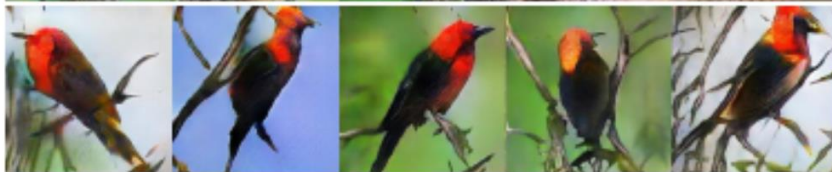
Chowdhury, A M Mahmud & Imtiaz, Masudul. (2022). Computational Intelligence for Solving the Biometric Enrollment Issue.

Generare text-imagine

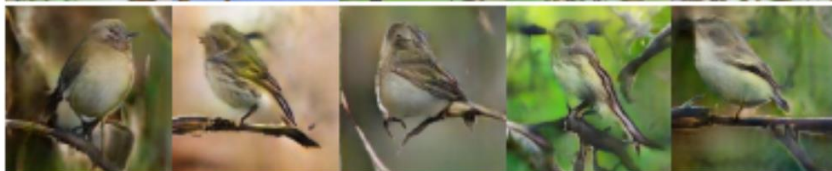
This small blue bird has a short pointy beak and brown on its wings



This bird is completely red with black wings and pointy beak



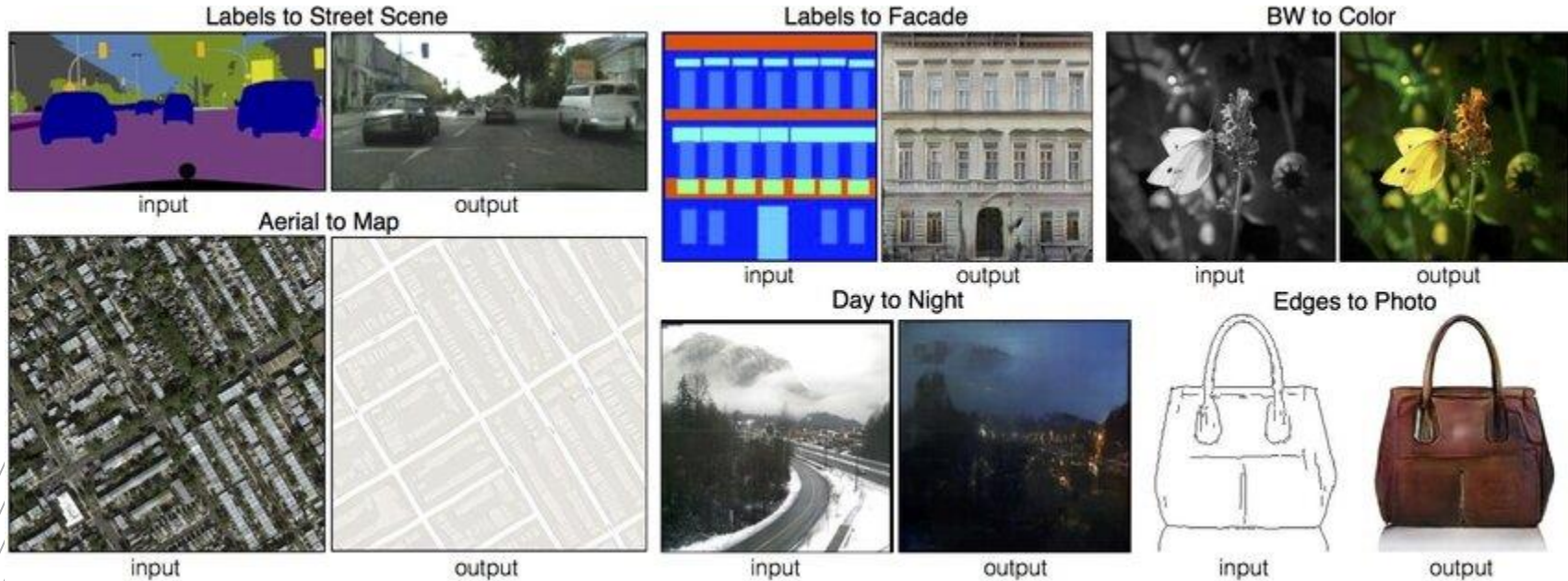
A small sized bird that has a cream belly and a short pointed bill



A small bird with a black head and wings and features grey wings



Paired image-to-image translation



P. Isola, J.-Y. Zhu, T. Zhou, and A. A. Efros, "Image-to-image translation with conditional adversarial networks," arxiv, 2016.

Resurse

I. Goodfellow et al., “GAN(Generative Adversarial Nets),” Journal of Japan Society for Fuzzy Theory and Intelligent Informatics, vol. 29, no. 5, p. 177, Oct. 2017, doi: 10.3156/jsoft.29.5_177_2.

M. Mirza and S. Osindero, “Conditional generative adversarial Nets,” arXiv (Cornell University), Jan. 2014, doi: 10.48550/arxiv.1411.1784.

H. Sen, “Understanding GANs — Deriving the Adversarial loss from scratch,” Medium, Mar. 07, 2024. [Online]. Available: <https://medium.com/analytics-vidhya/understanding-gans-deriving-the-adversarial-loss-from-scratch-ccd8b683d7e2>

J.-Y. Zhu, T. Park, P. Isola, and A. A. Efros, “Unpaired Image-to-Image Translation using Cycle-Consistent Adversarial Networks,” arXiv (Cornell University), Jan. 2017, doi: 10.48550/arxiv.1703.10593.

Computerphile, “Generative Adversarial Networks (GANs) - Computerphile” YouTube. Oct 25, 2017. [Online]. Available: <https://www.youtube.com/watch?v=Sw9r8CL98N0&t=78s>

