Moreno La Quatra
PhD Student @ DAUIN

Generative Adversarial Networks

Beyond discriminative models

Afternoon walk through the alleys of Ortygia in Siracusa Sicily.
Joanne Hastie original 2019 – CycleGAN
https://joannehastie.com/product/sicilian-alleyway/

Outline

- Discriminate or generate
- Short story: Mr. Gen & Prof. Dis
- Introduction to GANs
- Tasks in Computer Vision
- Demo
- Conclusions

1.

Generative
vs
Discriminative

Generative models

A generative model describes how a dataset is generated, in terms of a probabilistic model.

By sampling from this model, we are able to generate new data.

Generative deep learning (David Foster - O'Reilly)

https://thispersondoesnotexist.com

Francis Picabia Paintings

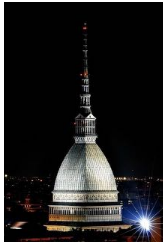
Discriminative

We could train a discriminative model to predict if a given painting was painted by **Francis Picabia**.

Generative

We could train a *generative* model to produce paintings that seems to be drawn by **Francis Picabia** himself.

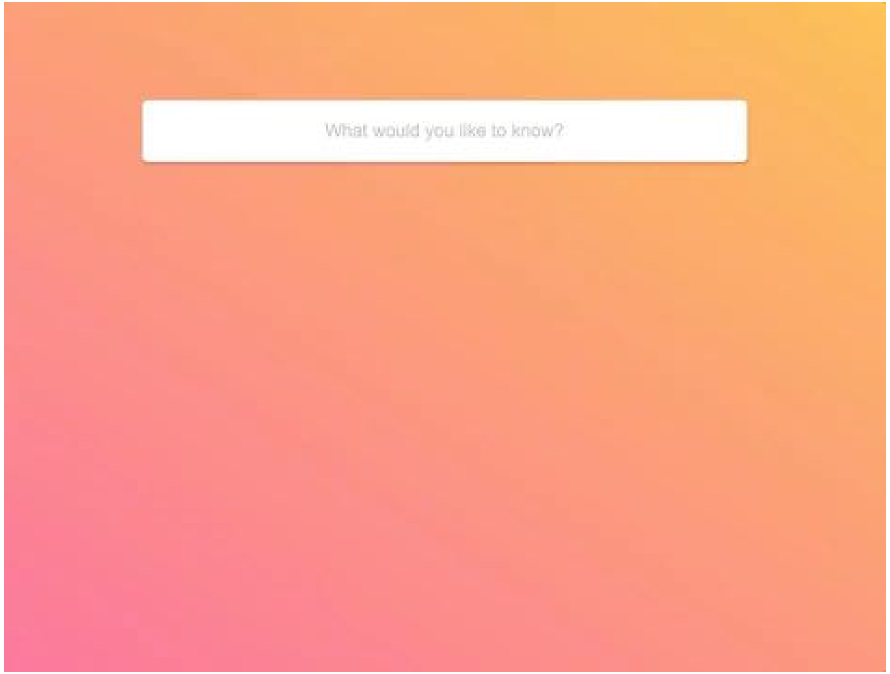





What can we do?

Discriminative

$$p(y|X = x)$$



Generative

$$p(x|Y = y)$$

Generative Adversarial Network is the most interesting idea in the last ten years in machine learning.

- Yann LeCun, Director, Facebook AI (Turing Prize)

2.

Mr. Gen
&
Prof. Dis

Studying for DSL Exam

DSL Exam

This is **Gen**, a PoliTO student

Gen studies for his DSL exam.

DSL Exam

Time for exam arrived. **Gen** answers to questions creating his output for the exam.

Prof. **Dis** examines the output produced by Gen and assign it a score.

DSL Exam

Is it good enough?

Unfortunately not. **Gen** needs to train harder to get a higher score.

DSL Exam

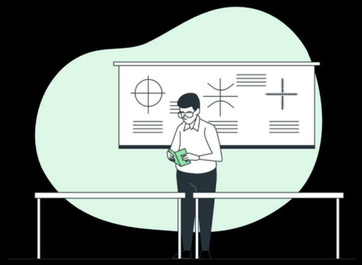
Second chance, now **Gen** knows what's wrong with his exam!

Again, Prof. **Dis** analyzes the exam and assign it a score.

Studying = Training

Gen is a generative model.
It is trained to produce more and more accurate results.

Prof. **Dis** is a discriminative model.
It evaluates samples.



[Training Phase]

Depending on the results of the exam, Gen adjusts the competencies to have better grades.

Studying = Training

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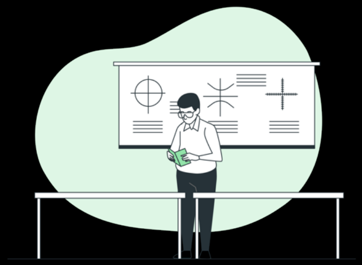


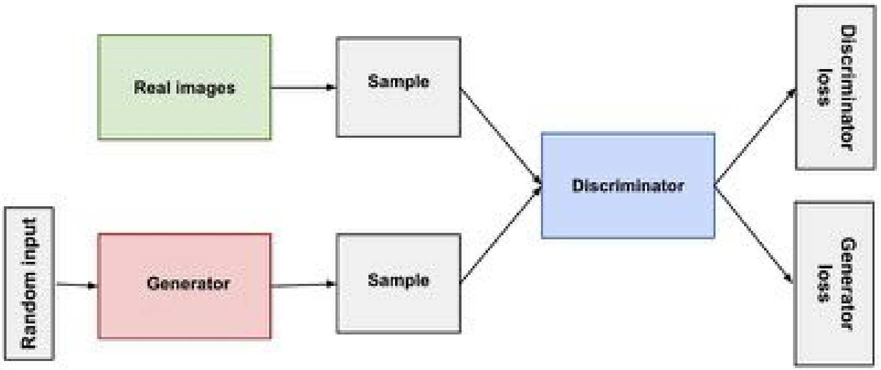
[Evaluation Phase]
Analyzing the exam solution and using his previous experience. Prof. Dis can evaluate the exam.

3.

GAN model
Architecture

GAN Architecture

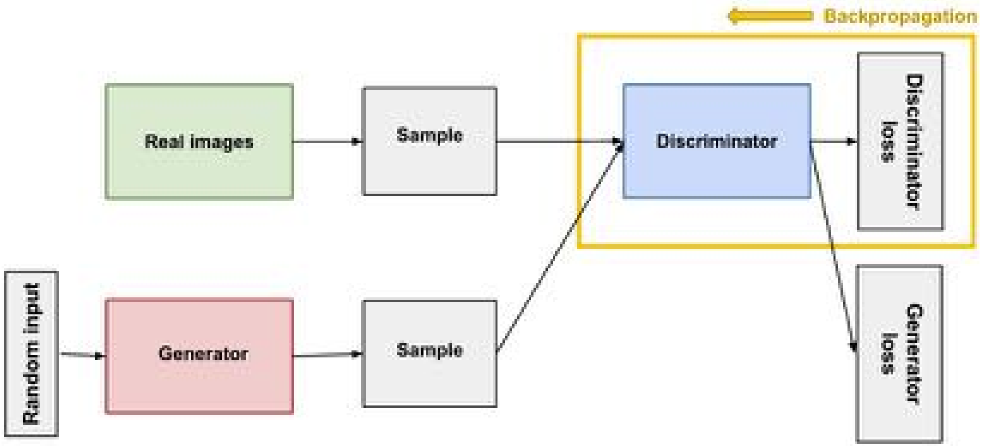
Similarly to the characters of our story, GANs have two main components.



Generator: learns to create data by incorporating feedback from the discriminator.

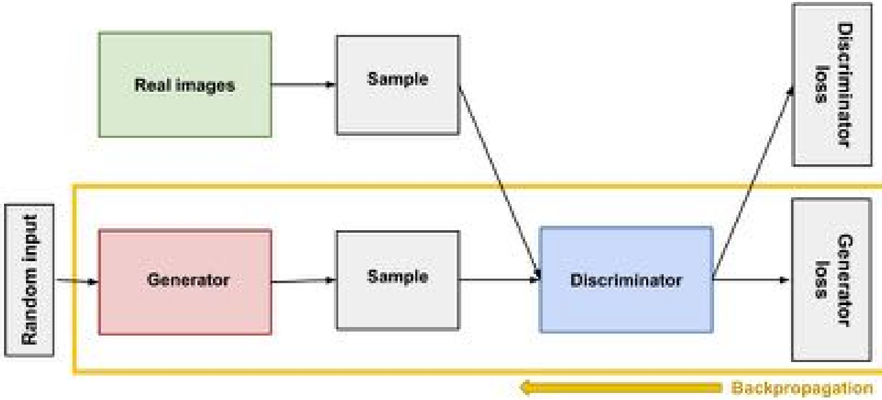
Discriminator: tries to distinguish real data from the data created by the generator.

Discriminator (Prof. Dis)



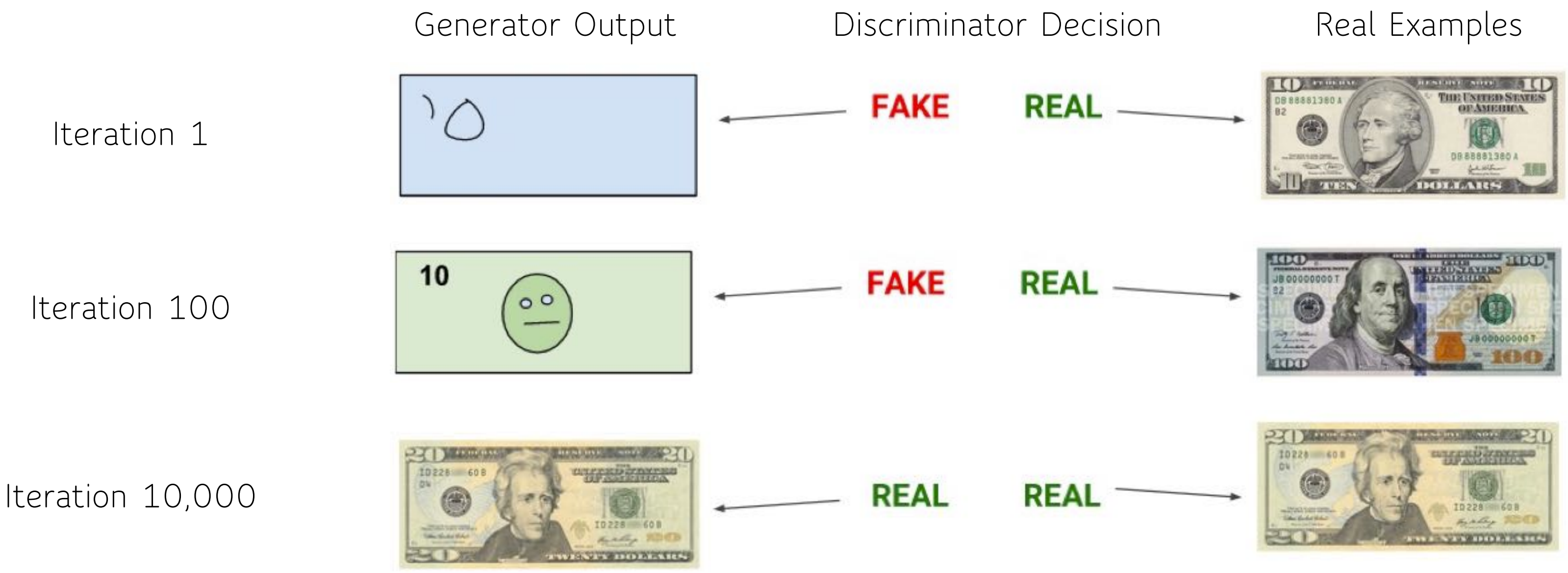
- It is trained to predict **False** on fake examples and **True** for real ones.
- It uses both real and fake examples and classify them using knowledge.
- Better the discriminator, harder the task for the generator.

Generator (Mr. Gen)



- Aims at fooling the discriminator (let it classify generated images as real).
- Uses random noise as input.
- The discriminator give it feedbacks by using the loss function.

Training Process

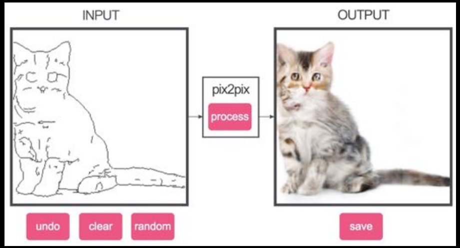


4.

GAN Tasks in Computer Vision

Computer vision tasks

Image-to-image translation



Super resolution

Semantic Image Syntesis

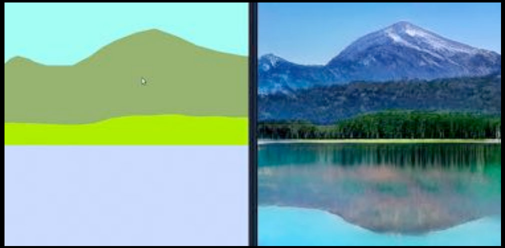


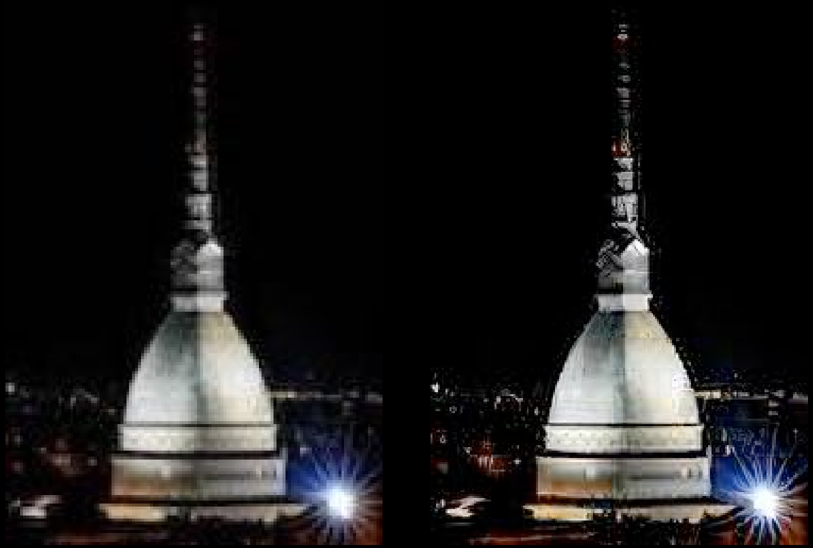
Image-to-image translation

GANs take an image as input and map it to a generated output image with different properties.

https://affinelayer.com/pixsrv/

Super-resolution

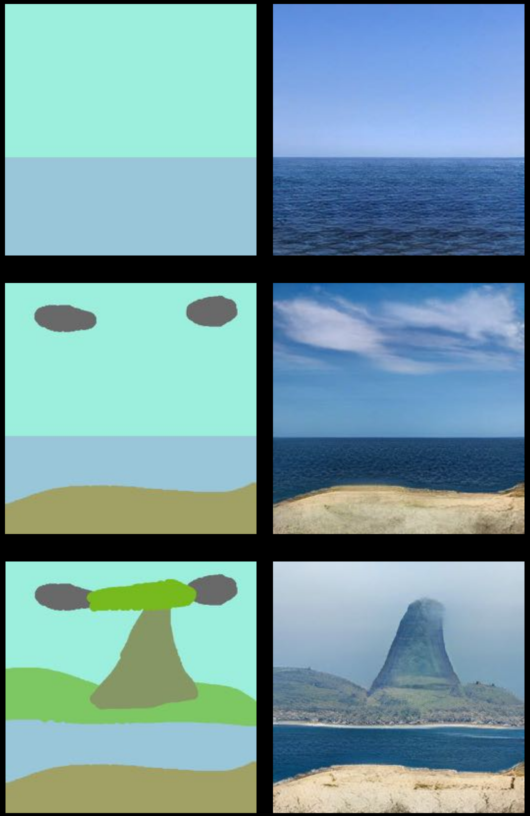
GANs increase the resolution of images, adding detail where necessary to fill in blurry areas.



https://deepai.org/machine-learning-model/torch-srgan

Semantic Image Syntesis

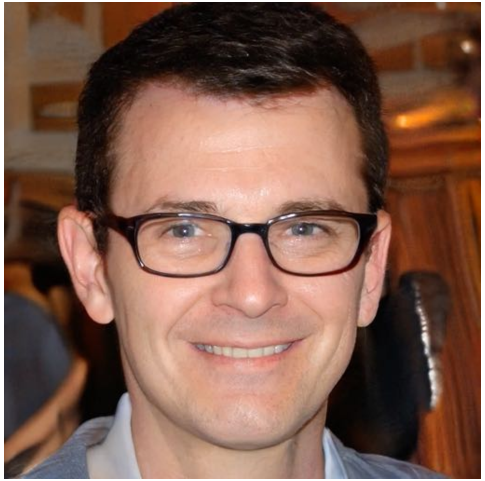
GANs take an image as input and map it to a generated output image with different properties.



http://nvidia-research-mingyuliu.com/gaugan/

Demo Time

How to generate people faces sampling from the **human** distribution.



https://colab.research.google.com/drive/1bOgTrP8_jBkay8u6oE610IAneCa15_2f?usp=sharing

Final Remarks

GANs can be used in **other fields** (NLP, Financial data, ...)

GANs are very un-optimized on **data usage**.

In the next future, it will be harder for humans to **distinguish** fake or real data.

GANs can be used for good but also for **illegal**/evil purposes.

It is relatively simple to find **blind spots** in the generator.

References

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Thanks!

Any question? I'll try to generate an answer for them!

Moreno La Quatra

PhD Student @ DAUIN

moreno.laquatra@polito.it