CSE4261: Neural Network and Deep Learning

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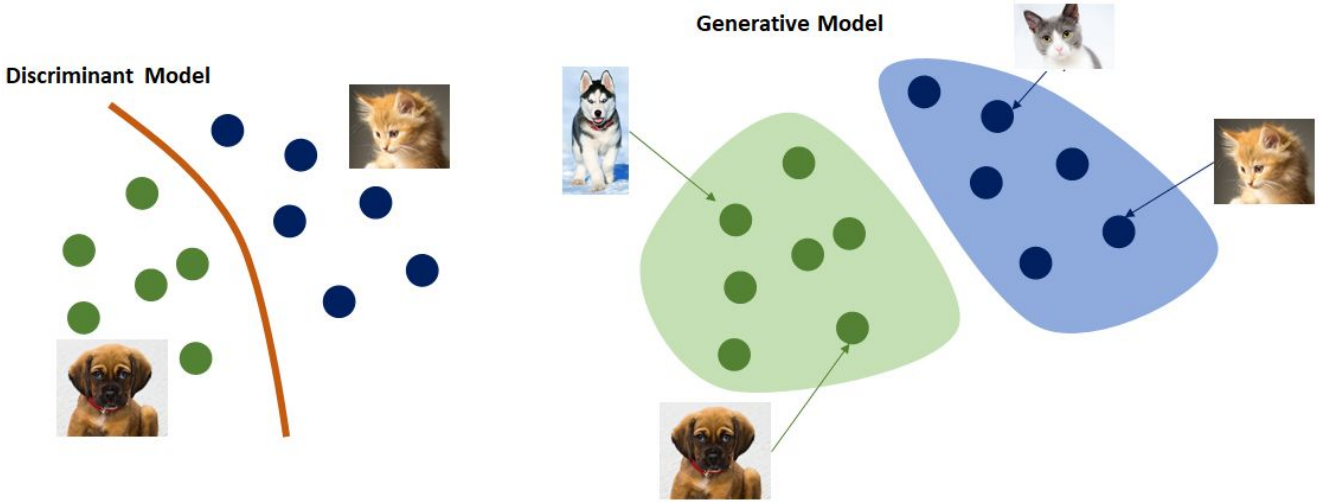
Model Types

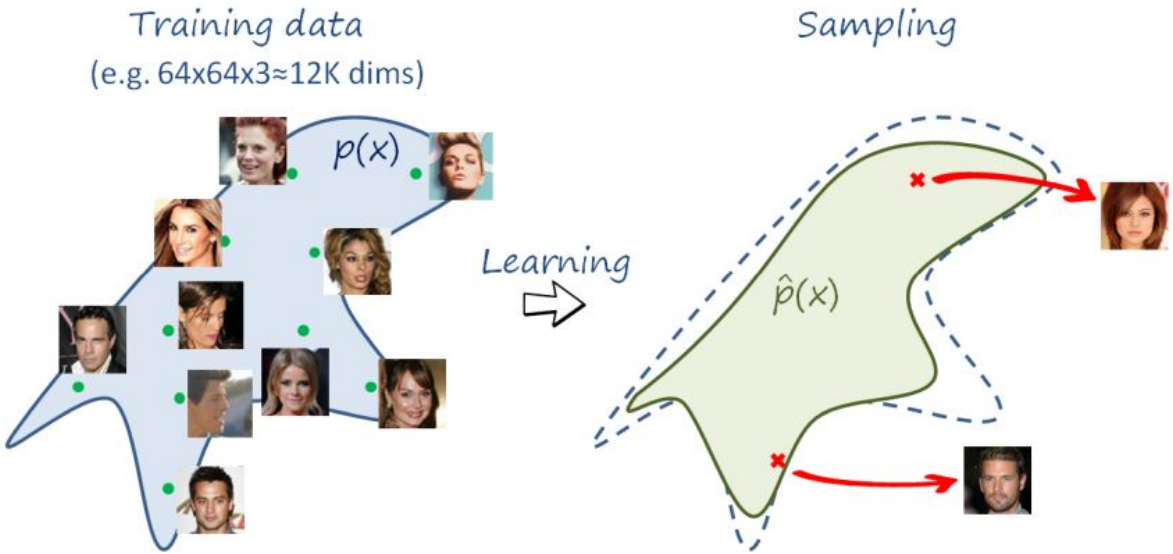
Models used in deep learning can be divided into two types:

- Discriminative Model: discriminates between different kinds of data samples.
- Generative Model: generates new data samples similar to the training data.

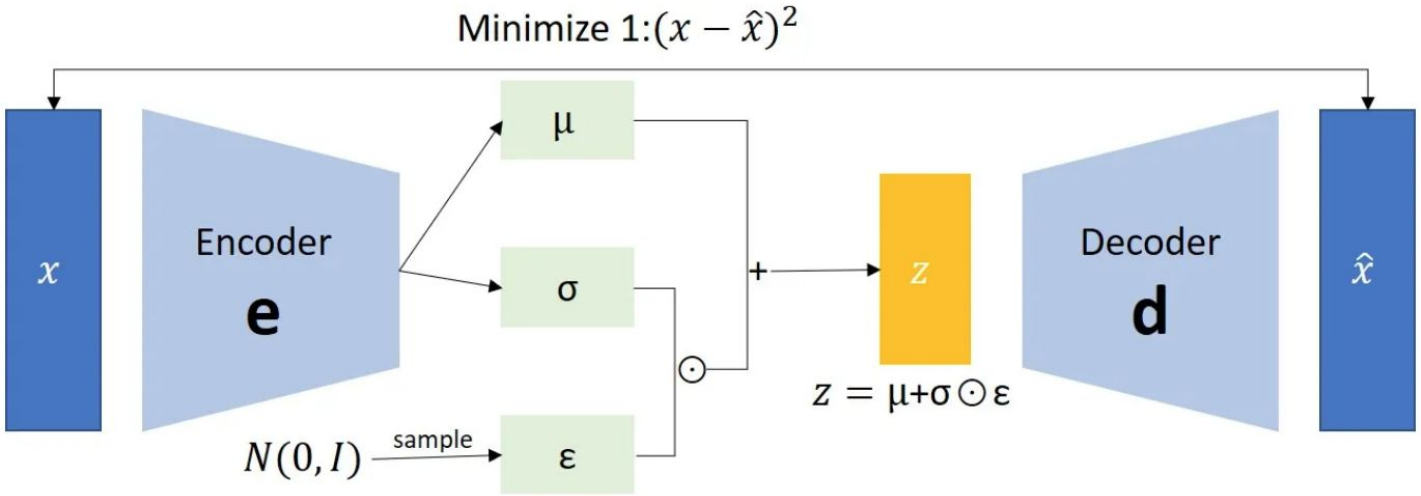


Generative Model

- It generates new data that is similar to the data it was trained on.
- It learns the underlying patterns or distributions of data and use learned distribution to generate new data.
- VAE, GANs are two popular generative models



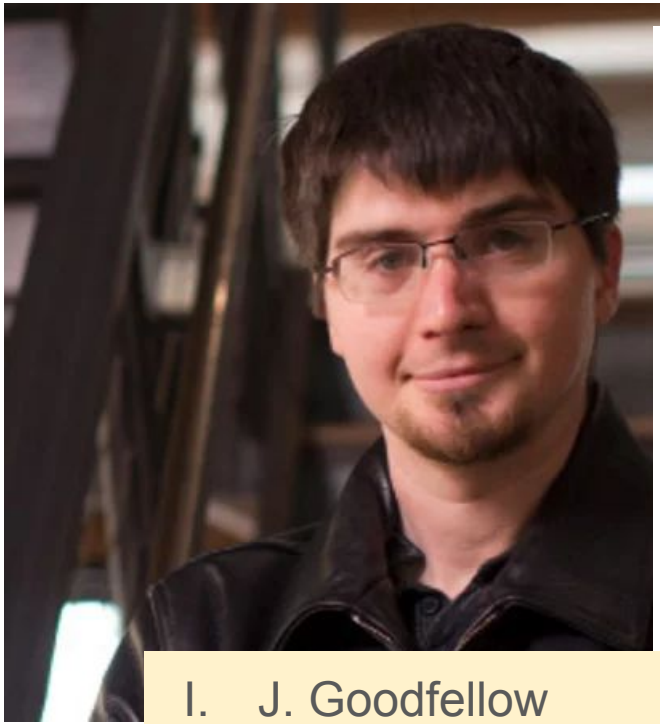
Variational Autoencoder (VAE)



Minimize 2: $\frac{1}{2}\sum_{i=1}^{N}(\exp(\sigma_i) - (1+\sigma_i) + {\mu_i}^2)$

Code: https://keras.io/examples/generative/vae/

GANs introduced in 2014 at NeuRIPS



I. J. Goodfellow

Generative Adversarial Nets

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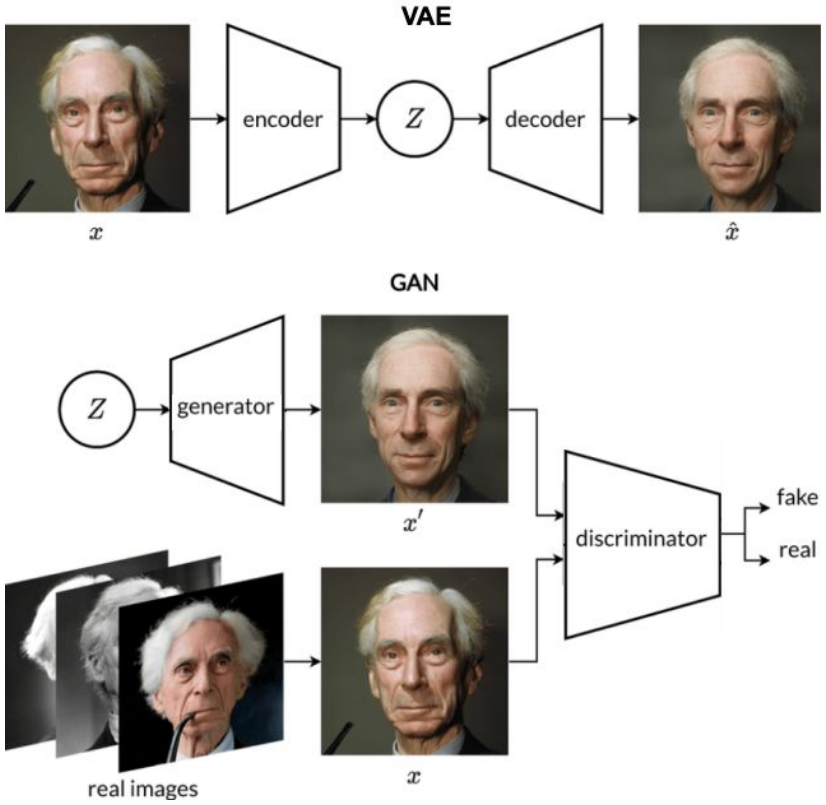
Abstract

We propose a new framework for estimating generative models via an adversarial process, in which we simultaneously train two models: a generative model G that captures the data distribution, and a discriminative model D that estimates the probability that a sample came from the training data rather than G. The training procedure for G is to maximize the probability of D making a mistake. This framework corresponds to a minimax two-player game. In the space of arbitrary

VAE vs GANs

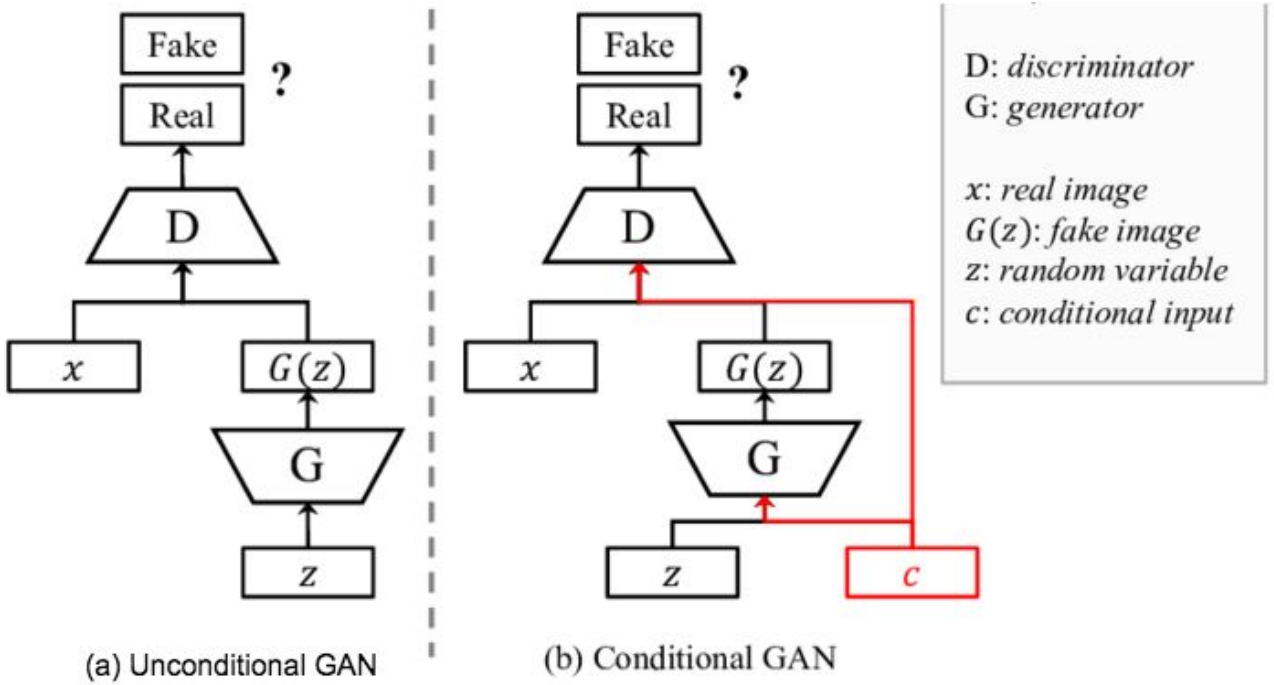
1. VAE: Variational Autoencoder
   - One network having two parts, **Encoder** and **Decoder**, is trained at the same time.
   - After training, **Encoder** is discarded and **Decoder** is kept to generate images from random or noise vectors
2. GANs: Generative Adversarial Networks
   - Two networks, **Generator** and **Discriminator**, are trained separately
   - After training, **Discriminator** is discarded and **Generator** is kept to generate images from random or noise vectors



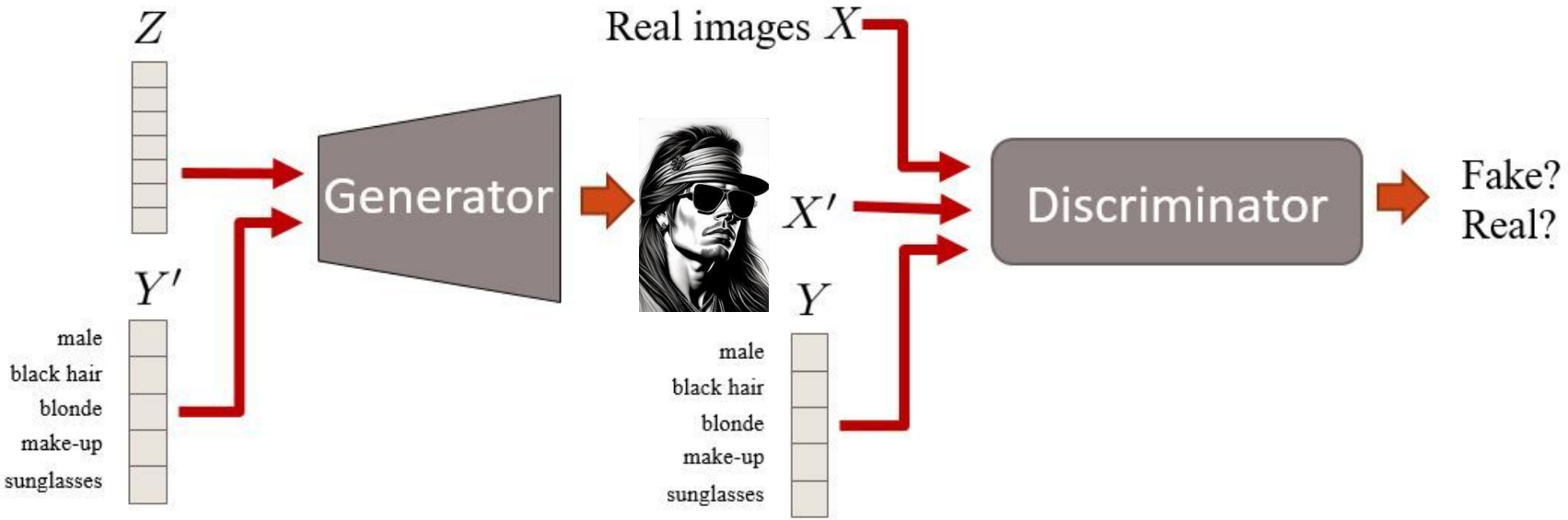
Types of GANs

1. Unconditional GANs (uGAN)
    - Generates images from noise vectors without any specific condition
    - Sample Code: https://keras.io/examples/generative/dcgan_overriding_train_step/
2. Conditional GANs (cGAN)
    - Generates images from noise vectors/candidate images and a condition vector
    - Sample Code: https://keras.io/examples/generative/conditional_gan/

uGAN vs cGAN


Fake
Real
?
D
x
G(z)
G
z
(a) Unconditional GAN
Fake
Real
?
D
x
G(z)
G
z
c
(b) Conditional GAN
D: discriminator
G: generator
x: real image
G(z): fake image
z: random variable
c: conditional input

Conditional GANs (cGAN)



Generate Images with Expressions by cGANs