Generative Adversarial Networks

A gentle introduction

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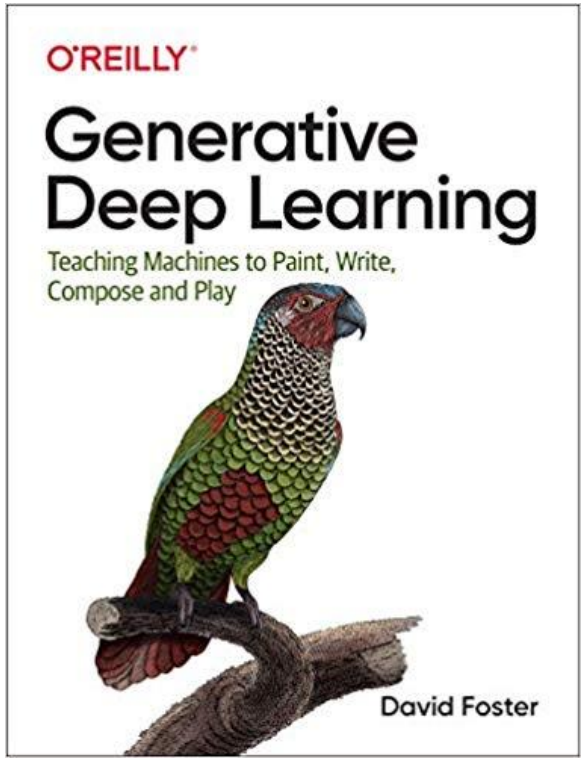
Outline

- Learning Goals
- Introduction
- Generative Adversarial Networks (GANs)
- Summary

Source Material

- Some of the contents of these slides are based on the book
- Other parts were developed by TA Abbas Mahbod



Learning Goals

- Introduce Generative Adversarial Networks
  - What they do
  - How they work

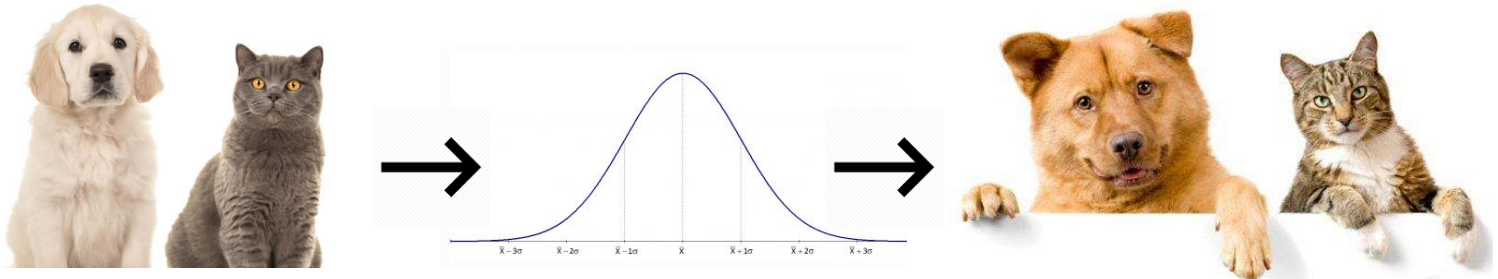
Introduction

- GANs are unsupervised deep learning methods
- GANs are considered one of the greatest deep learning breakthroughs in recent years
- There are many types of GANs
  - Wasserstein GAN
  - Cycle-GAN
- They all operate under the same principle of having modules with adversarial (*i.e.*, competing objectives)

What are GANs?

- GANs are generative models. What is a generative model?
- We have two different models in machine learning:
  - 1) Discriminative models

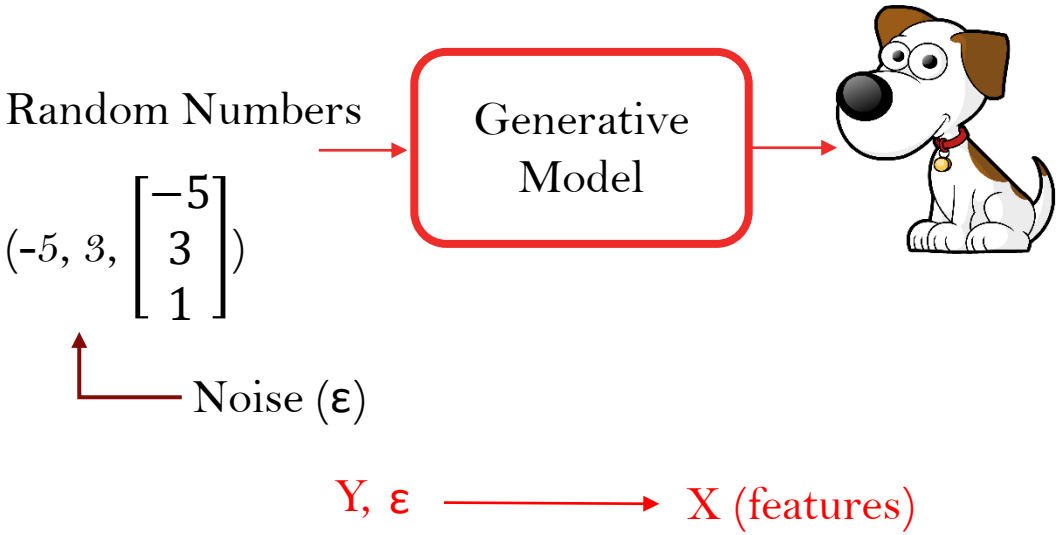
  - 2) Generative models



- Dataset
- Learning distribution
- New data

Machine Learning Models

- Generative Models
  - Generate realistic representation for each class.



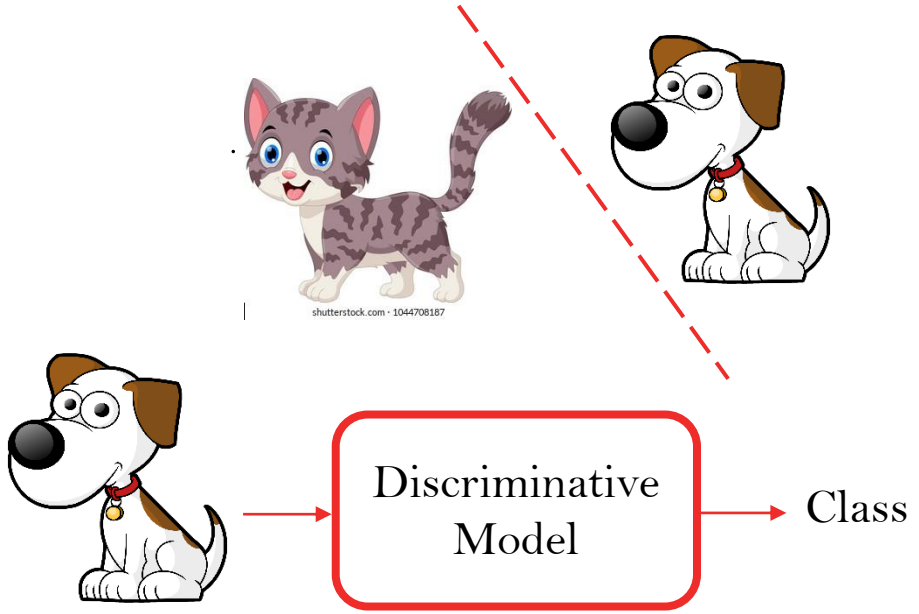
Y, ε → X (features)

$$P(X|Y)$$

or

$$P(X)$$

- Discriminative Models
  - Used for classification problem



X (features) → Y

$$P(Y|X)$$

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Generative Adversarial Networks

To produce Realistic Presentation of different classes

To distinguish real images from fake ones (produced by generator)

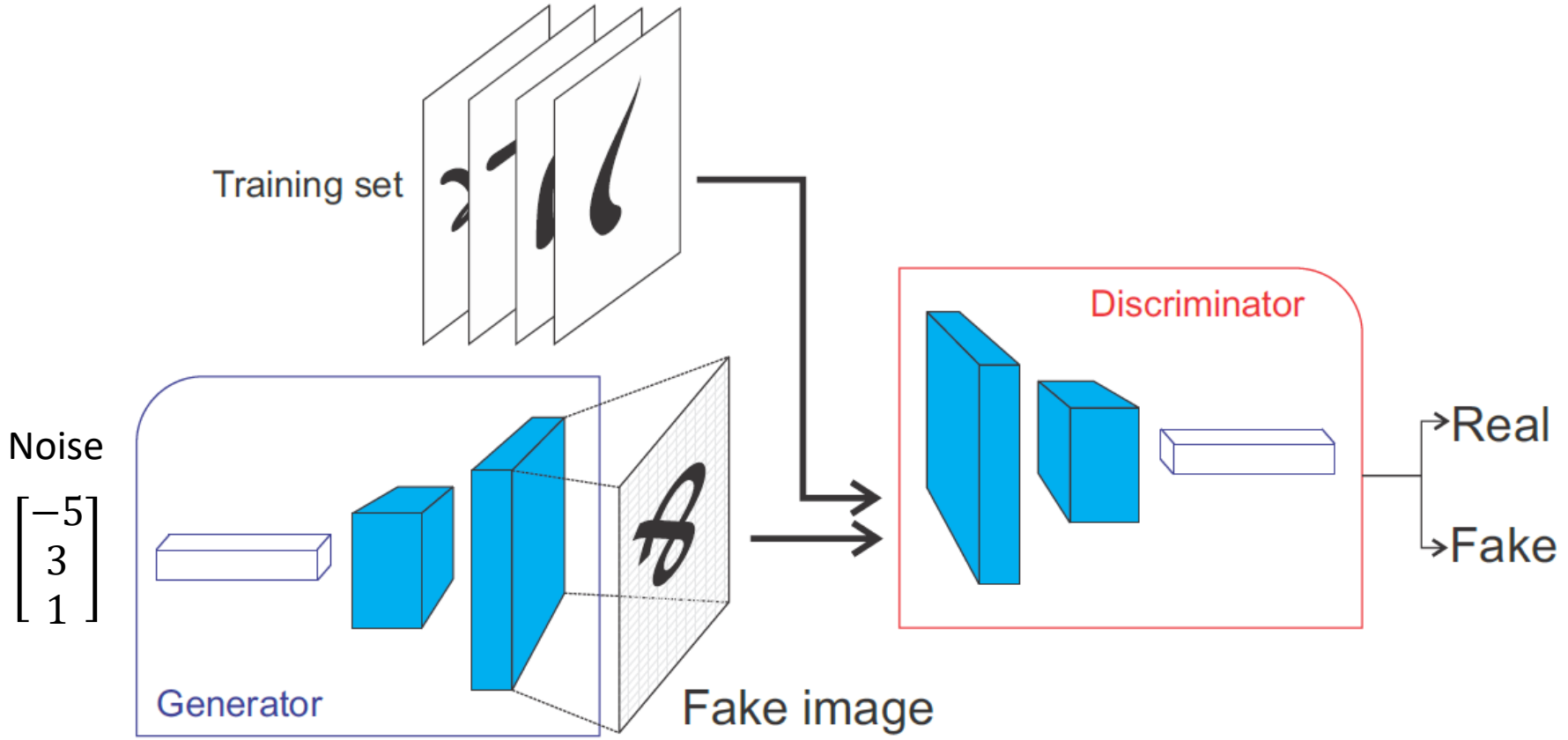
$$\begin{bmatrix} -5 \\ 3 \\ 1 \end{bmatrix}$$ → Generative Model →  → Discriminative Model → Fake/ Real

There is a competition here !

- Generator tries to make fakes that look real and fool the discriminator
- Discriminator learns how to distinguish reals from fakes

GANs are generative models where the data distribution is learned implicitly!

GAN



GANs Problems

- **Non-convergence**: the model parameters oscillate and the model does not converge
- **Mode collapse**: the generator collapses and produces a limited number of different samples
- **Diminished gradient**: the discriminator is too good that the generator gradient vanishes and learns nothing,
- **Highly sensitive** to the hyperparameter selections.

Summary

- GANs are unsupervised techniques
- They can be used to generate synthetic data that can potentially be used to train other deep learning models
- There are different GAN types, but they are all based on the principle of having two competing objectives
- GANs often face instabilities during training

Thank you!