Generative Adversarial Networks (GAN) Overview

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What are GANs?

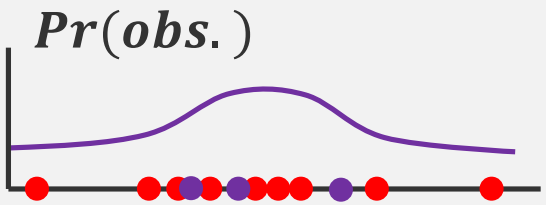
- System of two neural networks competing against each other in a game framework.
- They were first introduced by Ian Goodfellow *et al.* in 2014.
- Can learn to draw samples from a model that is similar to data that we give them.

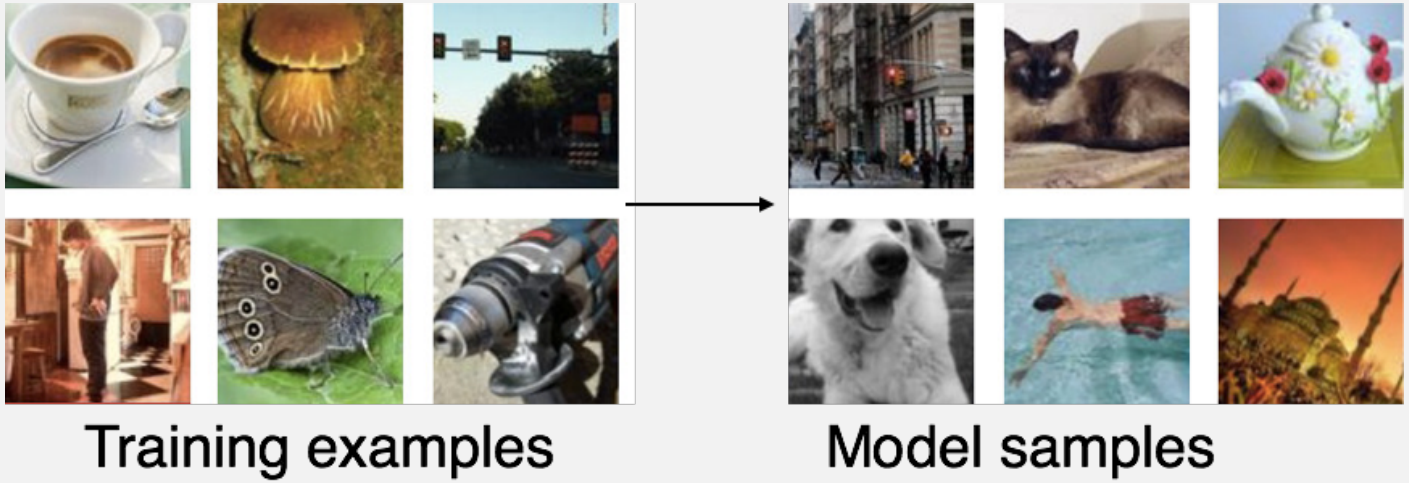
Probabilistic Generative Models

Density Estimation

- $Pr(observation) = Pr(synthetic\ obs.)$

Synthesizing Examples From Probabilistic Generative Model

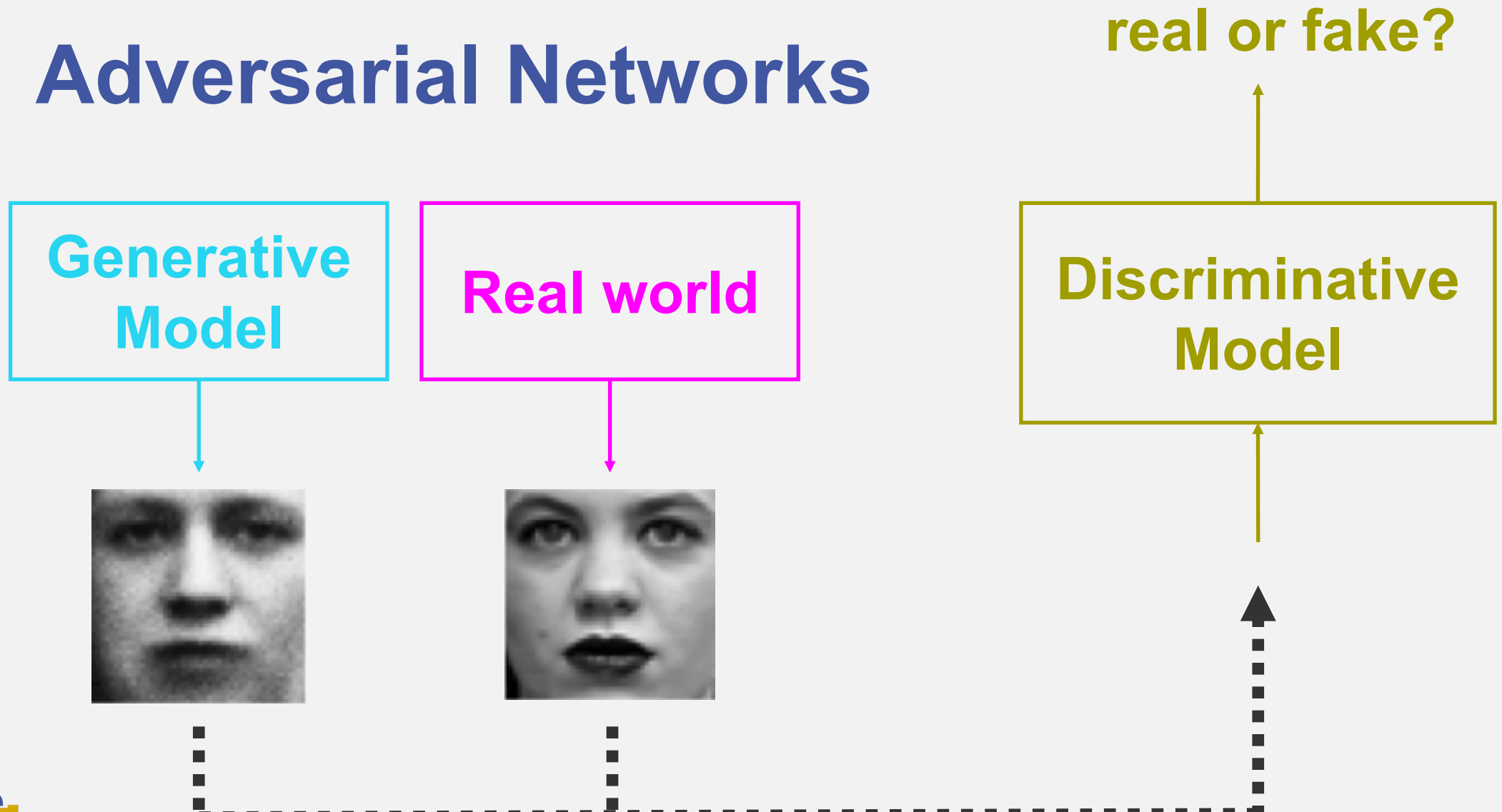




Goodfellow (2017)

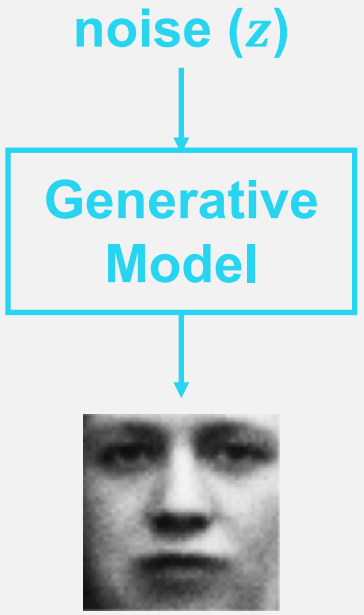
Goodfellow NIPS tutorial and accompanying paper (arXiv:1701.00160v4 [cs.LG]) provided some

Adversarial Networks



Generative Model

- How to make it generate different samples each time it is run?
  - input to model is noise
- Generative model as a neural network
  - computes $\boldsymbol{x} = \boldsymbol{G}(\boldsymbol{z}|\boldsymbol{\theta})$
  - differentiable
  - does not have to be invertible
  - $\boldsymbol{z}$ typically has very high dimensionality (higher than $\boldsymbol{x}$)



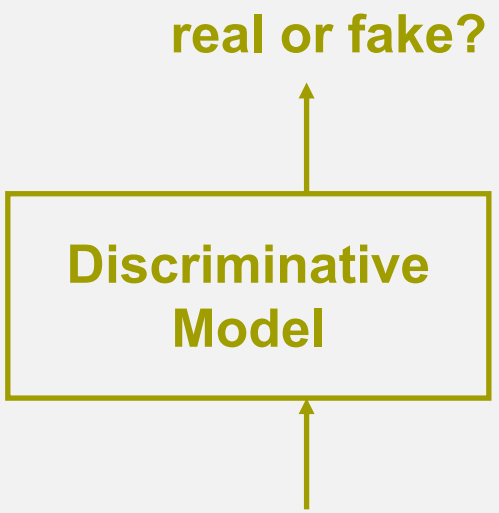
Generative Models

- A **generative** model tries to learn the joint probability of the input data and labels simultaneously i.e. *P(x,y)*.
- Potential to understand and explain the underlying structure of the input data even when there are no labels.

Discriminative Models

- A **discriminative** model learns a function that maps the input data (x) to some desired output class label (y).
- In probabilistic terms, they directly learn the conditional distribution $P(y|x)$.

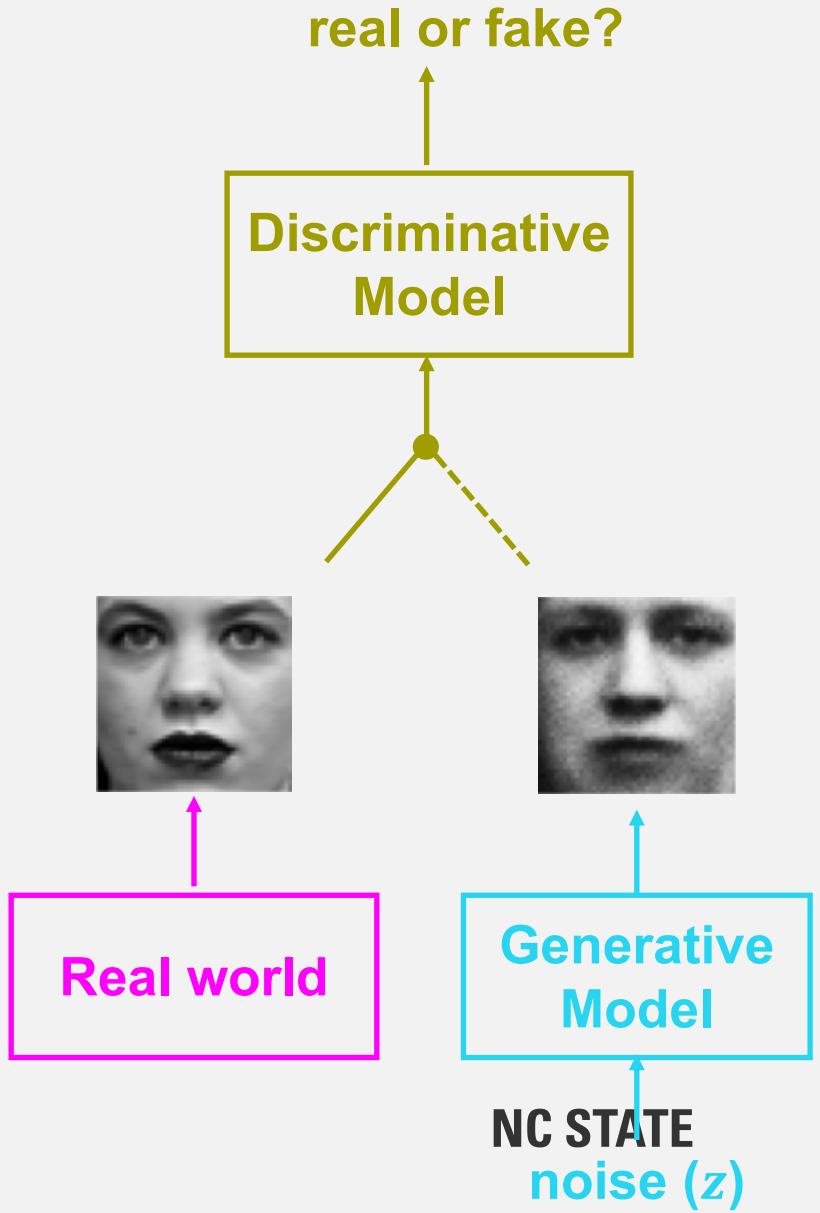
Discriminative Model



- Think of it as a critic
  - a good critic can tell real from fake
- Discriminative model as a neural net
  - differentiable
  - computes $\boldsymbol{D}(\boldsymbol{x})$, with value 1 if real, 0 if fake

Training Procedure: Basic Idea

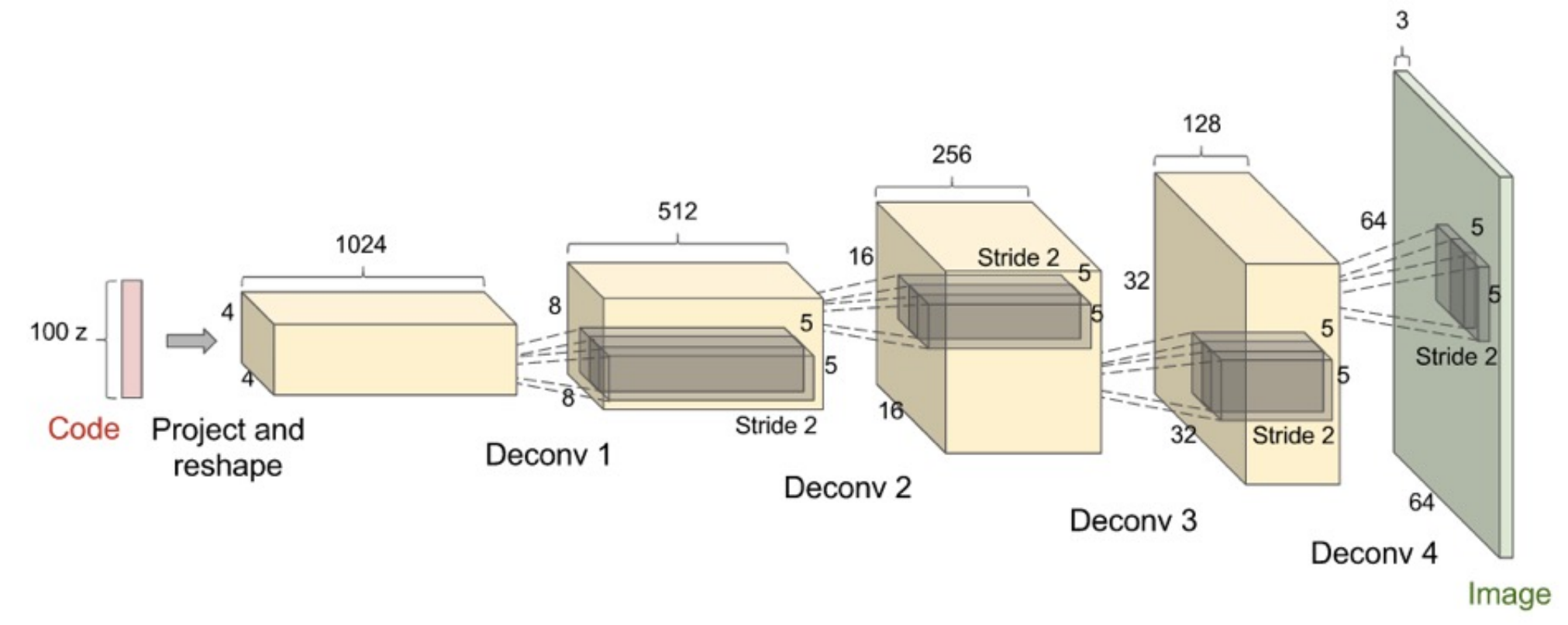
- G tries to fool D
- D tries not to be fooled
- Models are trained simultaneously
  - As G gets better, D has a more challenging task
  - As D gets better, G has a more challenging task
- Ultimately, we don't care about the D
  - Its role is to force G to work harder



How to train GANs?

- Objective of generative network - increase the error rate of the discriminative network.
- Objective of discriminative network – decrease binary classification loss.
- Discriminator training - backprop from a binary classification loss.
- Generator training - backprop the **negation** of the binary classification loss of the discriminator.

Deconvolutional GANs (DCGAN) (Radford et al., 2015)



Goodfellow (2017)

Deconvolutional GANs (DCGAN) (Radford et al., 2015)

Goodfellow (2017)

- Based on LSUN data set
  - 10 scene categories
  - 20 object categories
- ArXiv 1506.03365

Stay Connected

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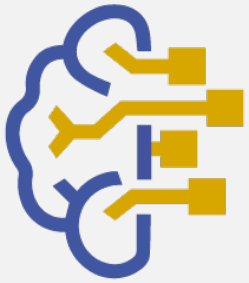

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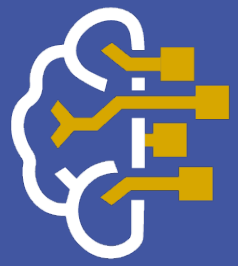

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