

Generative Adversarial Networks

Sargur N. Srihari
srihari@cedar.buffalo.edu

Topics

1. Generative adversarial networks (GAN)

Generative Adversarial Network (GAN)

- GANs are a generative modeling approach based on differentiable generator networks
 - Based on game-theoretic scenario in which the generator network competes against an adversary

Generative Adversarial Net (GAN)

- Simultaneously train two models
 - A generative model G that captures the data distribution
 - A discriminative model D that estimates a sample came from the training data rather than G
 - Training procedure for G is to maximize probability that G makes a mistake
- Framework corresponds to a minimax two-player game
 - For arbitrary G and D , a unique solution exists
 - If G and D are MLPs can be trained using backprop

Generator and Discriminator Networks

1. Generator Network directly produces samples

$$x = g(z; \theta^{(g)})$$

2. Discriminator Network, its adversary,
attempts to distinguish samples drawn from
training data and samples drawn from
generator

- Discriminator emits a probability value

- $d(x; \theta^{(d)})$ indicating the probability that x is a real training example rather than a fake sample drawn from the model

Deep Convolutional GAN (DCGAN)

- GAN architecture performs well when model architecture and hyperparameters are carefully selected
- A crafted DCGAN performs very well for image synthesis tasks
 - Latent representation space captures important factors of variation

Images generated by DCGAN



Images trained on the
LSUN data set

Images of bedrooms
generated by DCGAN

Conditional GAN

- GAN learning problem can be simplified by breaking the generation process into many levels of detail
- Can train conditional GANs that learn to sample from a distribution $p(\mathbf{x}|y)$ rather than simply sampling from the marginal distribution $p(\mathbf{x})$

The LAPGAN Model

- A series of conditional GANs can be trained to first generate a very low resolution version of an image
- Then incrementally add details to the image
- Called LAPGAN due to the use of a Laplacian pyramid to generate varying levels of detail

Images generated by LAPGAN



Images of churches
generated by LAPGAN model