Generative Adversarial Networks

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GAN

GAN is an algorithm that creates virtual images using deep learning.

For example, if we create a face, a deep learning algorithm predicts how image pixels should be combined to form the shape of the face.

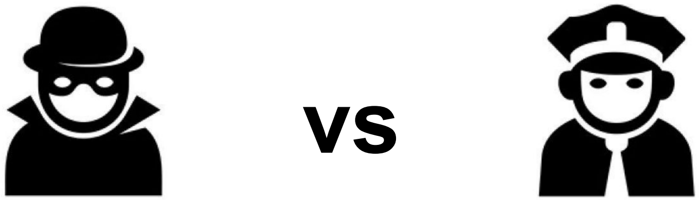
"Adversarial" shows the nature of the GAN algorithm well. This is because hostile/adversarial competition is conducted inside the GAN algorithm to create a 'real' fake.

GAN

Ian Goodfellow first proposed GAN.

To illustrate hostile contention, he gave examples of counterfeiters and police.

The competition between **counterfeit money criminals** who strive to make 'real' counterfeit bills and **police officers** who try to screen them out eventually results in a more sophisticated counterfeit bill.



Generative Adversarial Nets

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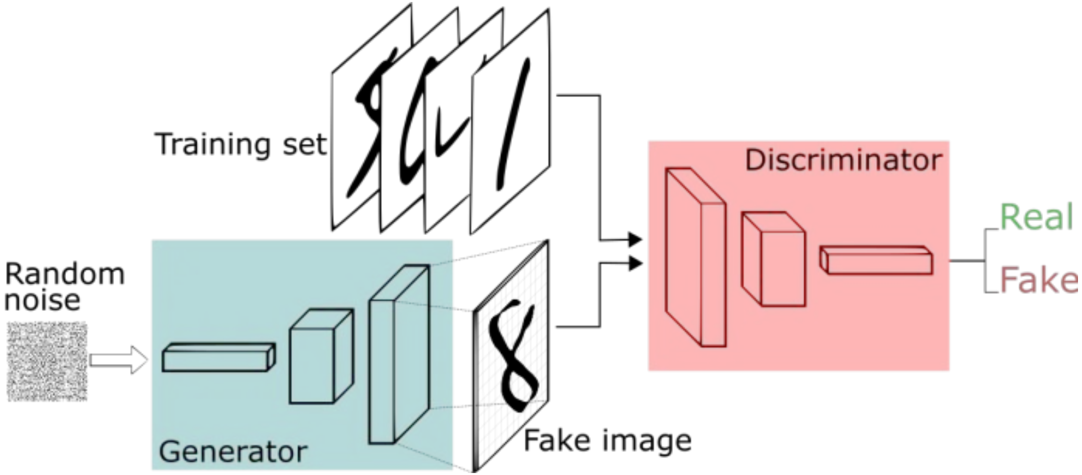
Abstract

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 functions G and D, a unique solution exists, with G recovering the training data distribution and D equal to $\frac{1}{2}$ everywhere. In the case where G and D are defined by multilayer perceptrons, the entire system can be trained with backpropagation. There is no need for any Markov chains or unrolled approximate inference networks during either training or generation of samples. Experiments demonstrate the potential of the framework through qualitative and quantitative evaluation of the generated samples.

Generator (criminal) and Discriminator (police)

The place where the fake is created is called the **generator**, and the place where the authenticity is determined is called the **discriminator**.



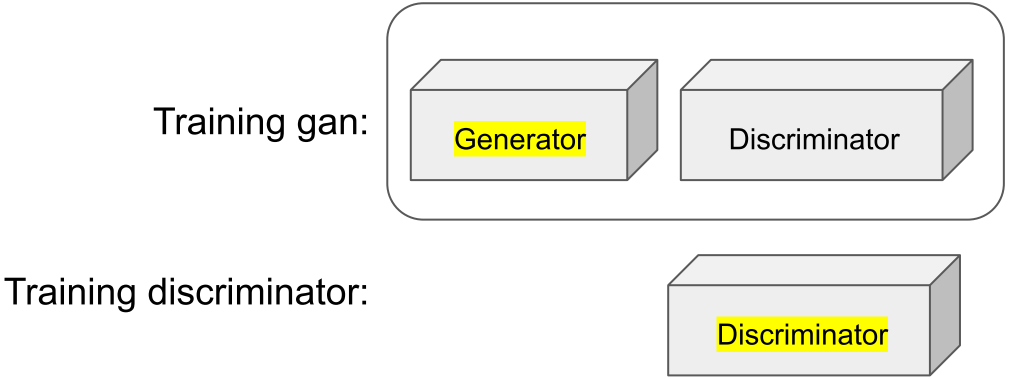
Cost function

$$\min_G \max_D V(D,G) = \mathbb{E}_{\boldsymbol{x} \sim p_{\text{data}}(\boldsymbol{x})}[\log D(\boldsymbol{x})] + \mathbb{E}_{\boldsymbol{z} \sim p_{\boldsymbol{z}}(\boldsymbol{z})}[\log(1 - D(G(\boldsymbol{z})))].$$

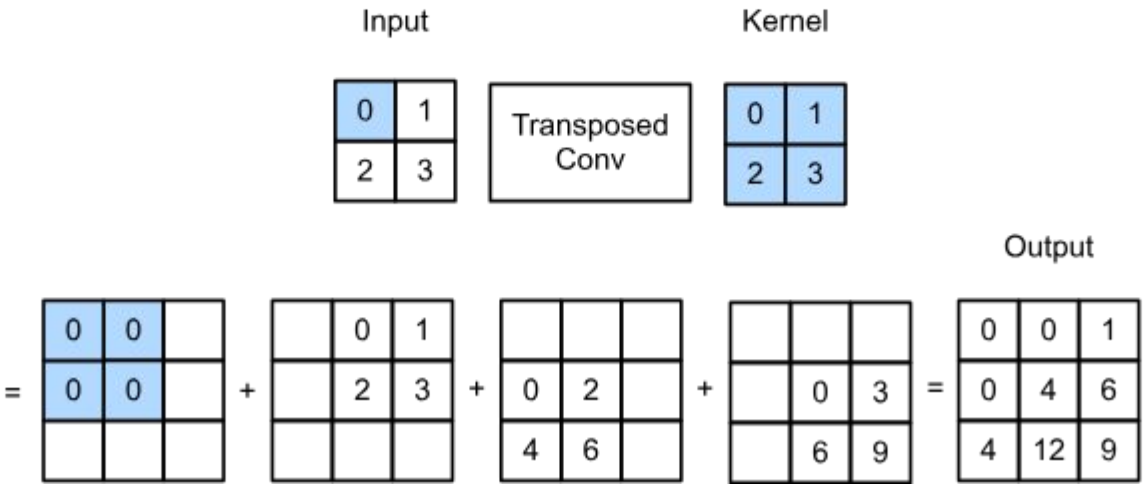
Training

Note that there are two models to train.

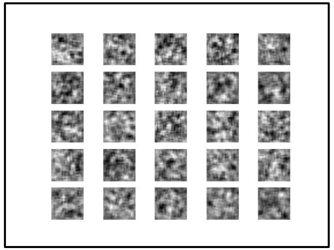
Training the models, **gan** and **discriminator**! Remember that we train only generator when we train gan. Separately, we train discriminator.



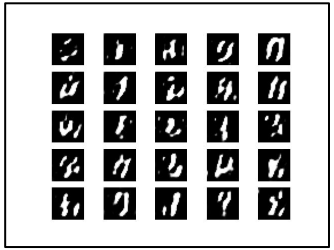
nn.ConvTranspose2d( )



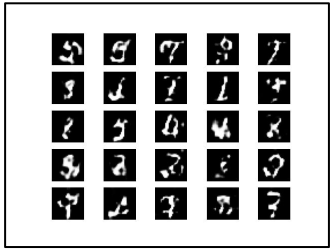
Results



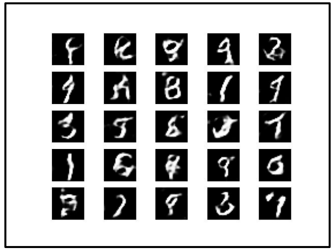
1 epoch



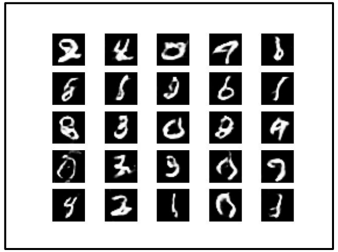
201 epoch



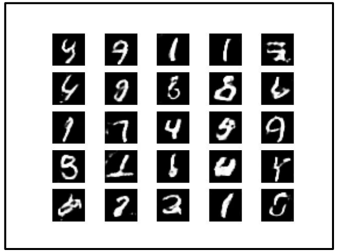
1001 epoch



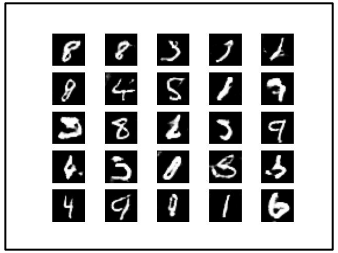
2001 epoch



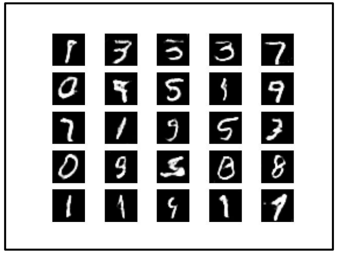
10001 epoch



20001 epoch



30001 epoch



40001 epoch

Evaluation

1. Average Log-likelihood
2. Coverage Metric
3. Inception Score (IS)
4. Modified Inception Score (m-IS)
5. Mode Score
6. AM Score
7. Frechet Inception Distance (FID)
8. Maximum Mean Discrepancy (MMD)
9. The Wasserstein Critic
10. Birthday Paradox Test
11. Classifier Two-sample Tests (C2ST)
12. Classification Performance
13. Boundary Distortion
14. Number of Statistically-Different Bins (NDB)
15. Image Retrieval Performance
16. Generative Adversarial Metric (GAM)
17. Tournament Win Rate and Skill Rating
18. Normalized Relative Discriminative Score (NRDS)
19. Adversarial Accuracy and Adversarial Divergence
20. Geometry Score
21. Reconstruction Error
22. Image Quality Measures (SSIM, PSNR and Sharpness Difference)
23. Low-level Image Statistics
24. Precision, Recall and F1 Score

Pros and Cons of GAN Evaluation Measures

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Abstract

Generative models, in particular generative adversarial networks (GANs), have gained significant attention in recent years. A number of GAN variants have been proposed and have been utilized in many applications. Despite large strides in terms of theoretical progress, evaluating and comparing GANs remains a daunting task. While several measures have been introduced, as of yet, there is no consensus as to which measure best captures strengths and limitations of models and should be used for fair model comparison. As in other areas of computer vision and machine learning, it is critical to settle on one or few good measures to steer the progress in this field. In this paper, I review and critically discuss more than 24 quantitative and 5 qualitative measures for evaluating generative models with a particular emphasis on GAN-derived models. I also provide a set of 7 desiderata followed by an evaluation of whether a given measure or a family of measures is compatible with them.

Keywords: Generative Adversarial Nets, Generative Models, Evaluation, Deep Learning, Neural Networks