Never trust a GAN

A comparative study of GAN, WGAN and WGAN with Spectral normalization

Milad TaghiKhaani, s212518

Haotian Liu, s212645

Mihaela Nistor, s183190

Kristine Ølgaard, s201952

THEORETICAL BACKGROUND

Generative Adversariual network (GAN)

The training process of a GAN can be seen as a two player game involving a discriminator network (D) and a generator network(G).G and D are trained together in a zero-sum game, adversarial, until D is fooled about half the time, meaning that G generates plausible examples.

The adversarial min-max game

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

Wasserstein GAN

WGAN is a type of generative adversarial network that minimizes an approximation of the Earth-Mover's distance (EM), that implies finding a 1-Lipschitz function. In practice, this means removing the sigmoid layer from the discriminator network and trading the BCE loss for the EM loss.

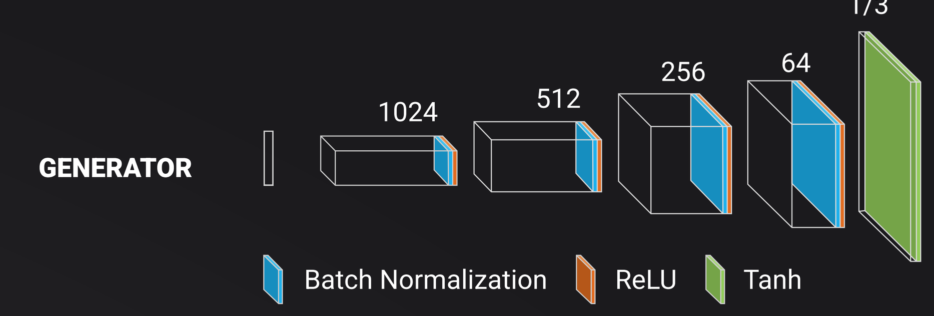
The *Earth-mover* (EM) distance

$$W(\mathbb{P}_r,\mathbb{P}_g) = \inf_{\gamma\in\prod(\mathbb{P}_r,\mathbb{P}_g)}\mathbb{E}_{(x,y)\sim\gamma}[\|x-y\|]$$

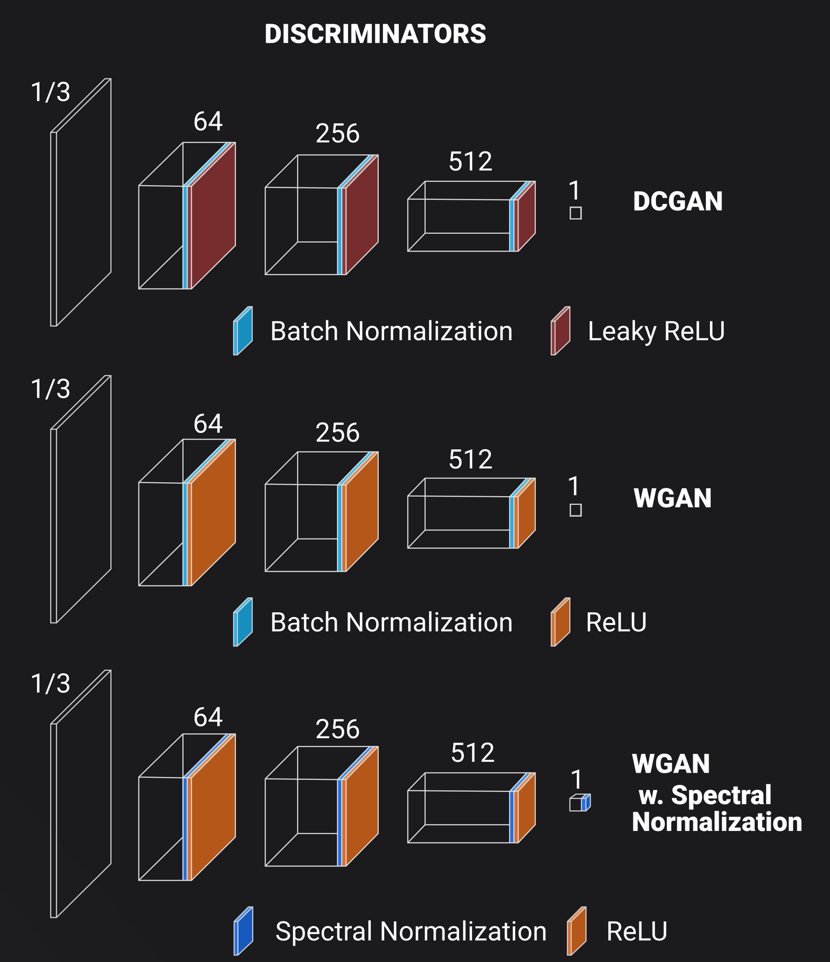
Never trust a GAN

- Ole Winther

ARCHITECTURE

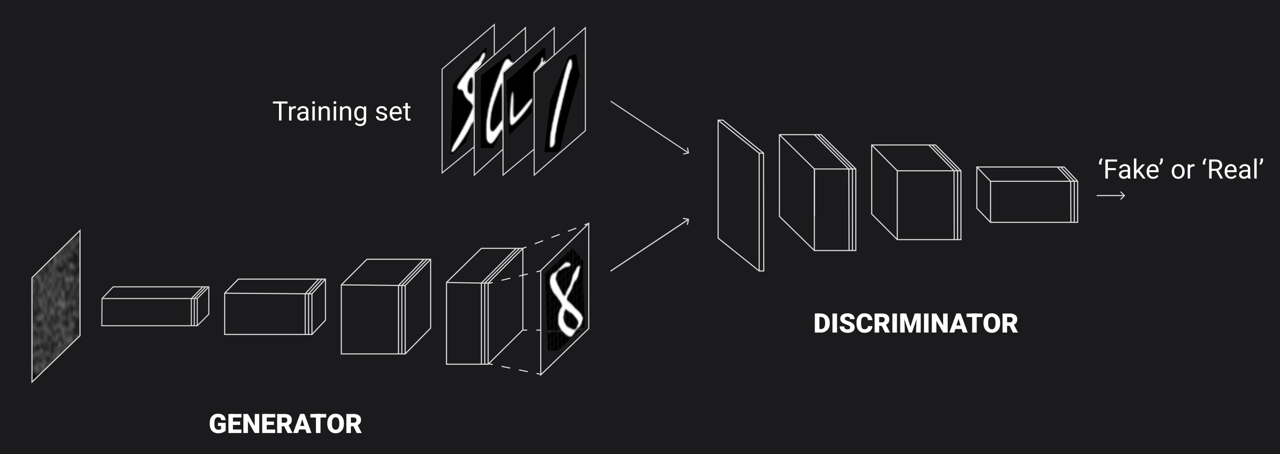


The architecture of the generator remains unchanged for the 3 models. The discriminator for DCGAN uses a sigmoid activation function in the output layer, while for WGAN and SNWGAN the sigmoid function is removed.The SNWGAN replaces batch normalization with spectral normalization.



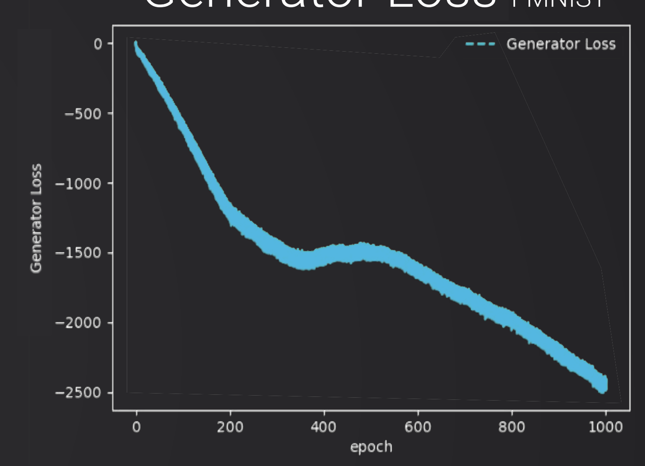
TRAINING

The discriminator is trained in two steps. The first step involves training on the real images. Then, the generator is asked to generate fake samples that are used to train the discriminator as a second step.

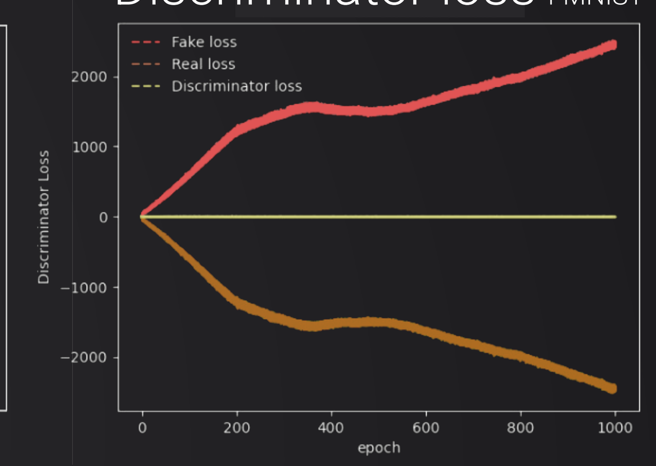


RESULTS

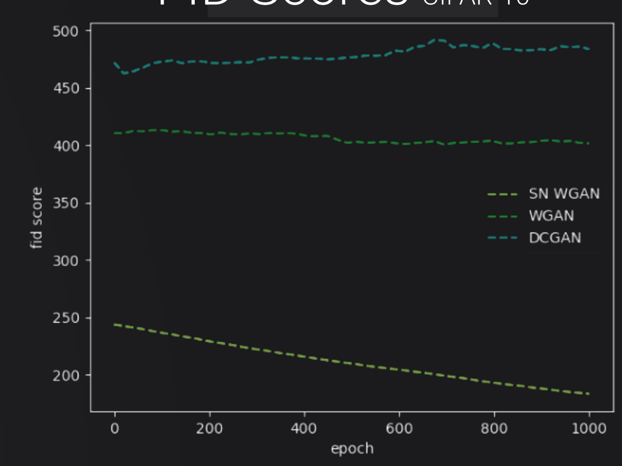
Generator Loss FMNIST

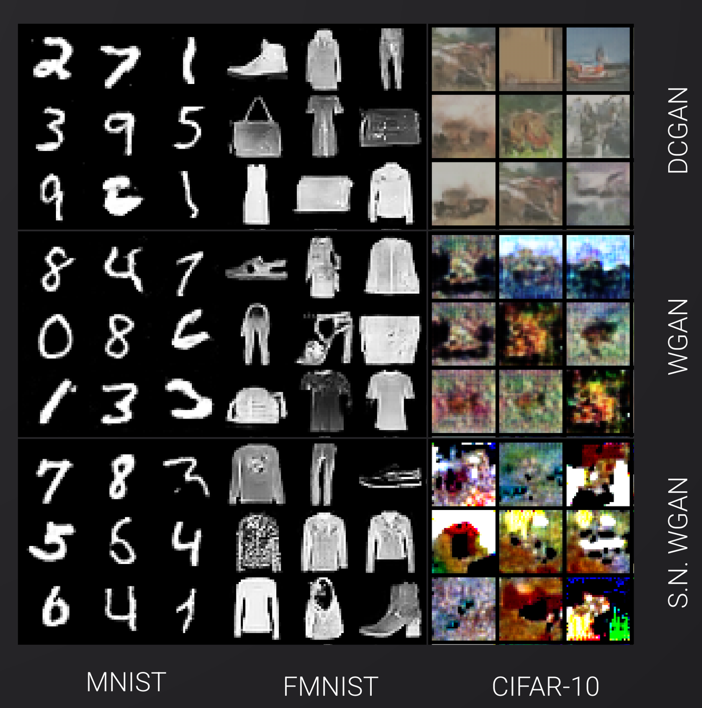


Discriminator loss FMNIST



FID Scores CIFAR-10





Based on the average FID scores, DCGAN shows good results on simple datasets such as MNIST and FashionMNIST, while SN.WGAN performs better on CIFAR-10.

SN.WGAN provides a meaningful loss curve, that is representative of its performance. This proves SN.WGAN as a reliable neural network.

In conclusion, the most suitable model very much depends on the task that one is trying to solve.

Comparative plot of FID scores
Lower is better!