Generative adversarial networks (GAN)

Vinay Joshi

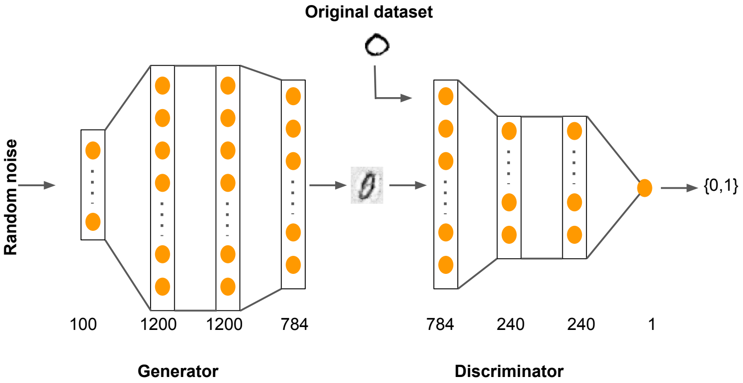
New Jersey Institute of Technology

vmj7@njit.edu

April 23, 2018

GAN architecture - Final

$\approx$ 2.75M trainable parameters



Generative Adversarial Network architecture

Objective for GAN

D → discriminator, G → generator
X → input data, Z → input noise

$$D\_loss = -log[D(X)] - log(1 - D(G(Z))) \tag{1}$$

$$G\_loss = -log[D(G(Z))] \tag{2}$$

$$\boxed{\text{At optimal, D(.) } = 0.5\text{, everywhere}}$$

Source: *IJ Goodfellow et. al. 2014*

Training procedure

Algorithm

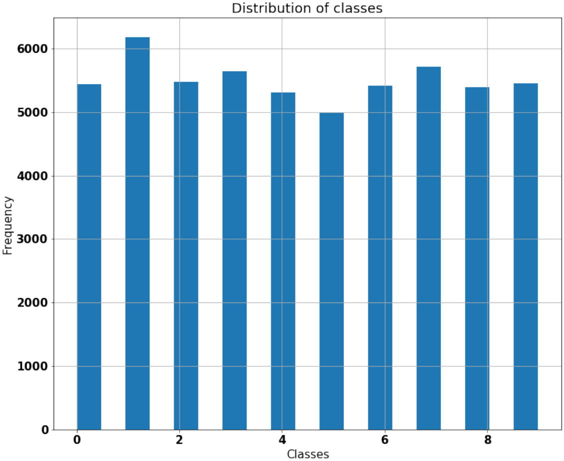
- **for** number of training iterations do:
    - **for** k steps do:
        - sample minibatch of size m of noise
        - sample minibatch of size m of images
        - Update descriminator to minimize *D_loss*
    - **end for**
    - sample minibatch of size m of noise
    - Update generator to minimize *G_loss*
- **end for**

Update rule: Momentum based gradient descent

Layer normalization: Batch normalization for generator

Tools & Dataset

- Python
- Tensorflow
- numpy
- Matplotlib
- Tensorboard
- MNIST dataset
- 55K train set
- 10K test set



Results on first attempt

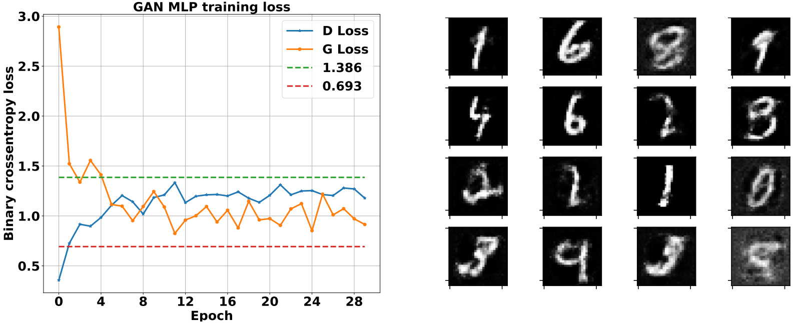


Figure: (L) G and D training loss, (R) Images generated by G at the end of 30th epoch

Extended training

Training for 100 epochs

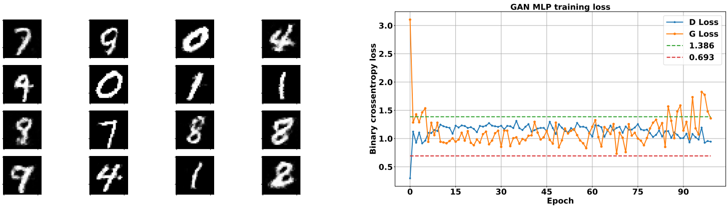


Figure: (L) G and D training loss, (R) Images generated by G at the end of 30th epoch

Different training techniques

PowerSign optimizer $\delta w_{new} = \delta w * \alpha^{f_n * sign(\delta w) * sign(momentum(\delta w))}$

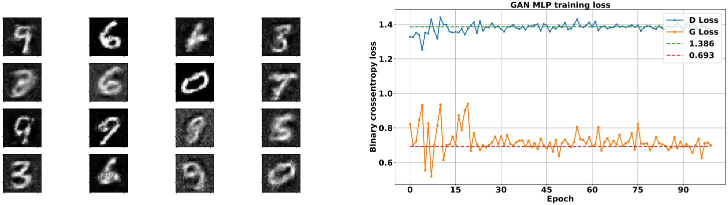


Figure: (L) G and D training loss, (R) Images generated by G at the end of 30th epoch

Different Activations

TanH activation in last layer of G and first layer of D

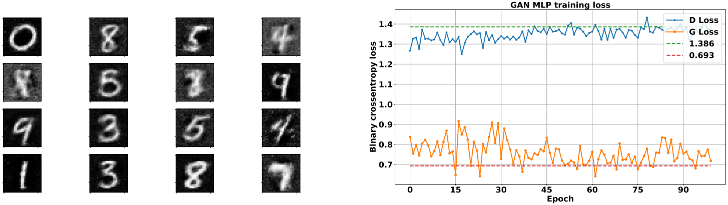


Figure: (L) G and D training loss, (R) Images generated by G at the end of 30th epoch

Noisy labels with Momentum optimizer

1 → U[0.7,1.2] and 0 → U[0.0,0.3]

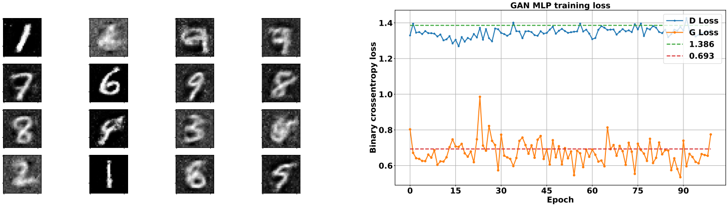


Figure: (L) G and D training loss, (R) Images generated by G at the end of 30th epoch

Noisy labels with PowerSign optimizer

1 → U[0.7,1.2] and 0 → U[0.0,0.3]

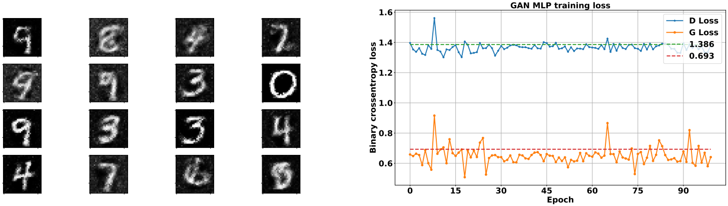


Figure: (L) G and D training loss, (R) Images generated by G at the end of 30th epoch

Noisy labels with PowerSign optimizer

1 → U[0.7,1.2] and 0 → U[0.0,0.3]

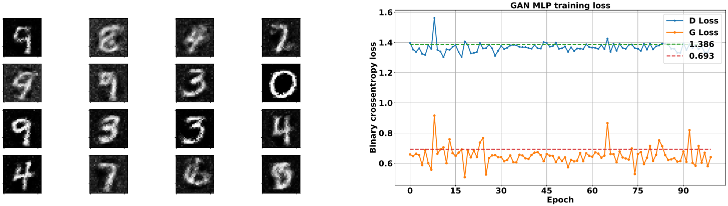


Figure: (L) G and D training loss, (R) Images generated by G at the end of 30th epoch

Comparison with other techniques

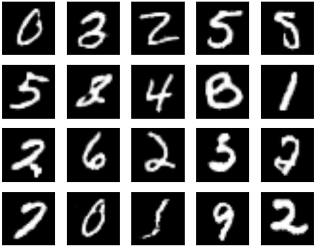


Figure: DCGAN - (https://github.com/acomets/dcgan)

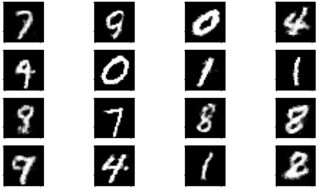


Figure: MLP-GAN