

Generative Adversarial Networks

December 21, 2017

1 GAN

```
In [1]: import tensorflow as tf
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline
```

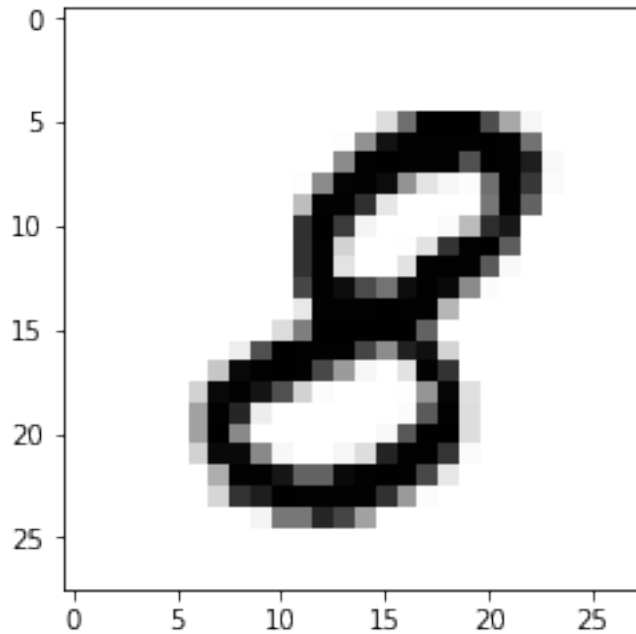
1.1 The Data

```
In [2]: from tensorflow.examples.tutorials.mnist import input_data
mnist = input_data.read_data_sets(
    "../03-Convolutional-Neural-Networks/MNIST_data/", one_hot=True)
```

```
Extracting ../03-Convolutional-Neural-Networks/MNIST_data/train-images-idx3-ubyte.gz
Extracting ../03-Convolutional-Neural-Networks/MNIST_data/train-labels-idx1-ubyte.gz
Extracting ../03-Convolutional-Neural-Networks/MNIST_data/t10k-images-idx3-ubyte.gz
Extracting ../03-Convolutional-Neural-Networks/MNIST_data/t10k-labels-idx1-ubyte.gz
```

```
In [3]: plt.imshow(mnist.train.images[5].reshape(28,28), cmap='Greys')
```

```
Out[3]: <matplotlib.image.AxesImage at 0x1e8b2ca6160>
```



2 The Networks

Useful Links:

<https://stackoverflow.com/questions/45307072/using-leaky-relu-in-tensorflow>

2.0.1 Activation Function

2.1 The Generator

```
In [4]: def generator(z, reuse=None):
        with tf.variable_scope('gen', reuse=reuse):
            hidden1 = tf.layers.dense(inputs=z, units=128)
            # Leaky Relu
            alpha = 0.01
            hidden1 = tf.maximum(alpha*hidden1, hidden1)
            hidden2 = tf.layers.dense(inputs=hidden1, units=128)
            hidden2 = tf.maximum(alpha*hidden2, hidden2)
            output = tf.layers.dense(hidden2, units=784, activation=tf.nn.tanh)
            return output
```

2.2 The Discriminator

```
In [5]: def discriminator(X, reuse=None):
        with tf.variable_scope('dis', reuse=reuse):
```

```

hidden1 = tf.layers.dense(inputs=X,units=128)
# Leaky Relu
alpha = 0.01
hidden1 = tf.maximum(alpha*hidden1,hidden1)

hidden2 = tf.layers.dense(inputs=hidden1,units=128)
hidden2 = tf.maximum(alpha*hidden2,hidden2)

logits = tf.layers.dense(hidden2,units=1)
output = tf.sigmoid(logits)

return output, logits

```

2.2.1 Placeholders

```

In [6]: real_images = tf.placeholder(tf.float32,shape=[None,784])
        z = tf.placeholder(tf.float32,shape=[None,100])

```

2.2.2 Generator

```

In [7]: G = generator(z)

```

2.2.3 Discriminator

```

In [8]: D_output_real , D_logits_real = discriminator(real_images)

```

```

In [9]: D_output_fake, D_logits_fake = discriminator(G,reuse=True)

```

2.2.4 Losses

```

In [10]: def loss_func(logits_in,labels_in):
          return tf.reduce_mean(
              tf.nn.sigmoid_cross_entropy_with_logits(
                  logits=logits_in,labels=labels_in))

In [11]: D_real_loss = loss_func(D_logits_real,tf.ones_like(D_logits_real)* (0.9))

In [12]: D_fake_loss = loss_func(D_logits_fake,tf.zeros_like(D_logits_real))

In [13]: D_loss = D_real_loss + D_fake_loss

In [14]: G_loss = loss_func(D_logits_fake,tf.ones_like(D_logits_fake))

```

2.2.5 Optimizers

```

In [15]: learning_rate = 0.001

In [16]: tvars = tf.trainable_variables()

        d_vars = [var for var in tvars if 'dis' in var.name]

```

```

g_vars = [var for var in tvars if 'gen' in var.name]

print([v.name for v in d_vars])
print([v.name for v in g_vars])

['dis/dense/kernel:0', 'dis/dense/bias:0', 'dis/dense_1/kernel:0', 'dis/dense_1/bias:0', 'dis/de
['gen/dense/kernel:0', 'gen/dense/bias:0', 'gen/dense_1/kernel:0', 'gen/dense_1/bias:0', 'gen/de

In [17]: D_trainer = tf.train.AdamOptimizer(
        learning_rate).minimize(D_loss, var_list=d_vars)
        G_trainer = tf.train.AdamOptimizer(
        learning_rate).minimize(G_loss, var_list=g_vars)

```

2.3 Training Session

```

In [18]: batch_size = 100
        epochs = 500
        init = tf.global_variables_initializer()
        saver = tf.train.Saver(var_list=g_vars)

In [19]: # Save a sample per epoch
        samples = []

In [20]: with tf.Session() as sess:

        sess.run(init)

        # Recall an epoch is an entire run through the training data
        for e in range(epochs):
            # // indicates classic division
            num_batches = mnist.train.num_examples // batch_size

            for i in range(num_batches):

                # Grab batch of images
                batch = mnist.train.next_batch(batch_size)

                # Get images, reshape and rescale to pass to D
                batch_images = batch[0].reshape((batch_size, 784))
                batch_images = batch_images*2 - 1

                # Z (random latent noise data for Generator)
                # -1 to 1 because of tanh activation
                batch_z = np.random.uniform(-1, 1, size=(batch_size, 100))

                # Run optimizers, no need to save outputs, we won't use them
                _ = sess.run(D_trainer,
                            feed_dict={real_images: batch_images, z: batch_z})

```

```

        _ = sess.run(G_trainer, feed_dict={z: batch_z})

    print("Currently on Epoch {} of {} total...".format(e+1, epochs))

    # Sample from generator as we're training for viewing afterwards
    sample_z = np.random.uniform(-1, 1, size=(1, 100))
    gen_sample = sess.run(generator(z ,
                                    reuse=True), feed_dict={z: sample_z})

    samples.append(gen_sample)

#         saver.save(sess, './models/500_epoch_model.ckpt')

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```
In [21]: saver = tf.train.Saver(var_list=g_vars)
```

```
new_samples = []  
with tf.Session() as sess:  
  
    saver.restore(sess, './models/500_epoch_model.ckpt')  
  
    for x in range(5):  
        sample_z = np.random.uniform(-1,1,size=(1,100))  
        gen_sample = sess.run(generator(  
            z,reuse=True),feed_dict={z:sample_z})
```

```
new_samples.append(gen_sample)
```

```
In [33]: plt.imshow(samples[0].reshape(28,28),cmap='Greys')
```

```
Out[33]: <matplotlib.image.AxesImage at 0x1e8b97cc748>
```

