Análisis de Datos y Aprendizaje Máquina con Tensorflow 2.0: Perceptrón Multicapa

2019/09/30

1 Batch Normalization

Objetivo: Comprender batch normalization y sus parámetros

- Referencia: https://arxiv.org/abs/1502.03167
- Batch Normalization ayuda a que la red se entrene de forma estable, normalizando la entrada o salida de las activaciones
- A cada activación se le resta la media y se divide por la desviación estándar del batch

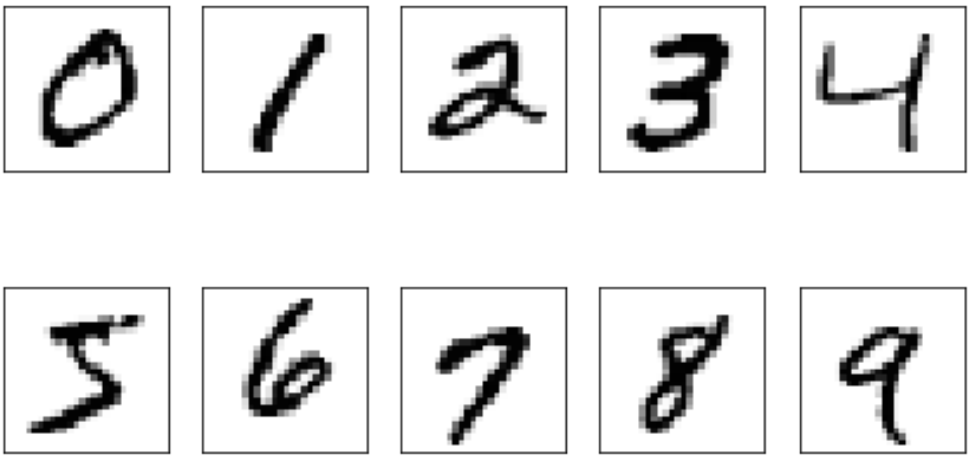
```
In [1]: import matplotlib.pyplot as plt
        import tensorflow as tf
        from tensorflow import keras
        from tensorflow.keras.layers import BatchNormalization, Activation
        from tensorflow.keras.models import Sequential
        from tensorflow.keras.layers import Dense
        from tensorflow.keras import backend as K
        K.clear_session()

        mnist = keras.datasets.mnist

        (x_train, y_train), (x_test, y_test) = mnist.load_data()
```

```
In [2]: print(x_train.shape)
        print(y_train.shape)
        print(x_test.shape)
        print(y_test.shape)
```

```
(60000, 28, 28)
(60000,)
(10000, 28, 28)
(10000,)
```

1.1 Leer Dataset

```
In [3]: fig, ax = plt.subplots(nrows=2, ncols=5, sharex=True, sharey=True,)
        ax = ax.flatten()
        for i in range(10):
            img = x_train[y_train == i][0].reshape(28, 28)
            ax[i].imshow(img, cmap='Greys', interpolation='nearest')

        ax[0].set_xticks([])
        ax[0].set_yticks([])
        plt.tight_layout()
        plt.show()
```



- Se modifica la forma de los datos de 2-d (n, 28, 28) a 1-d (n, 784)

```
In [4]: x_train = x_train.reshape(x_train.shape[0], -1)
        x_test = x_test.reshape(x_test.shape[0], -1)


        print(x_train.shape) # (60000, 784)
        print(y_train.shape) # (60000,)
        print(x_test.shape)  # (10000, 784)
        print(y_test.shape)  # (10000,)
```

```
(60000, 784)
(60000,)
(10000, 784)
(10000,)
```

```
In [5]: epoch = 100
        verbose = 0
        batch = 50
```

1.2 Momentum

Para controlar la cantidad de estadísticas del mini batch anterior, el parámetro 'momentum' por defecto tiene valor de 0.99. Esto se puede establecer en 0.0 para usar solo estadísticas del mini batch actual.

```
In [6]: def make_model():
            model = Sequential()

            model.add(Dense(40, input_shape = (784, ), activation = 'relu'))
            model.add(Dense(40, activation = 'relu'))
            model.add(Dense(40, activation = 'relu'))
            model.add(Dense(10, activation = 'softmax'))


            model.compile(optimizer='adam', loss='sparse_categorical_crossentropy',
                          metrics=['accuracy'])
            return model
```

```
In [7]: model = make_model()

        model.summary()
```

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense (Dense)                (None, 40)                31400
_________________________________________________________________
dense_1 (Dense)              (None, 40)                1640
_________________________________________________________________
dense_2 (Dense)              (None, 40)                1640
_________________________________________________________________
dense_3 (Dense)              (None, 10)                410
=================================================================
Total params: 35,090
Trainable params: 35,090
Non-trainable params: 0
_________________________________________________________________
```

```
In [8]: history1 = model.fit(x_train, y_train, batch_size = batch, validation_split = 0.3,
                             epochs = epoch, verbose = verbose)
```

```
In [9]: test_loss, test_acc = model.evaluate(x_test,  y_test, verbose=2)

        print('\nTest acccuracy:', test_acc)
```

```
10000/1 - 0s - loss: 0.1850 - accuracy: 0.9623

Test acccuracy: 0.9623
```

```
In [10]: def make_model():
             model = Sequential()

             model.add(Dense(40, input_shape = (784, ), activation = 'relu'))
             model.add(BatchNormalization(momentum=0.99))        # capa Batchnorm
             model.add(Dense(40, activation = 'relu'))
             model.add(BatchNormalization(momentum=0.99))        # capa Batchnorm
             model.add(Dense(40, activation = 'relu'))
             model.add(BatchNormalization(momentum=0.99))        # capa Batchnorm
             model.add(Dense(10, activation = 'softmax'))


             model.compile(optimizer='adam', loss='sparse_categorical_crossentropy',
                           metrics=['accuracy'])
             return model

In [11]: model = make_model()

         model.summary()

Model: "sequential_1"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_4 (Dense)              (None, 40)                31400
_________________________________________________________________
batch_normalization (BatchNo (None, 40)                160
_________________________________________________________________
dense_5 (Dense)              (None, 40)                1640
_________________________________________________________________
batch_normalization_1 (Batch (None, 40)                160
_________________________________________________________________
dense_6 (Dense)              (None, 40)                1640
_________________________________________________________________
batch_normalization_2 (Batch (None, 40)                160
_________________________________________________________________
dense_7 (Dense)              (None, 10)                410
=================================================================
Total params: 35,570
Trainable params: 35,330
Non-trainable params: 240
_________________________________________________________________


In [12]: history2 = model.fit(x_train, y_train, batch_size = batch, validation_split = 0.3,
                              epochs = epoch, verbose = verbose)

In [13]: test_loss, test_acc = model.evaluate(x_test,  y_test, verbose=2)

         print('\nTest acccuracy:', test_acc)
```

```
10000/1 - 1s - loss: 0.0683 - accuracy: 0.9734

Test acccuracy: 0.9734
```

```
In [14]: def make_model():
             model = Sequential()

             model.add(Dense(40, input_shape = (784, ), activation = 'relu'))
             model.add(BatchNormalization(momentum=0.5))        # capa Batchnorm
             model.add(Dense(40, activation = 'relu'))
             model.add(BatchNormalization(momentum=0.5))        # capa Batchnorm
             model.add(Dense(40, activation = 'relu'))
             model.add(BatchNormalization(momentum=0.5))        # capa Batchnorm
             model.add(Dense(10, activation = 'softmax'))


             model.compile(optimizer='adam', loss='sparse_categorical_crossentropy',
                           metrics=['accuracy'])
             return model
```

```
In [15]: model = make_model()

         model.summary()
```

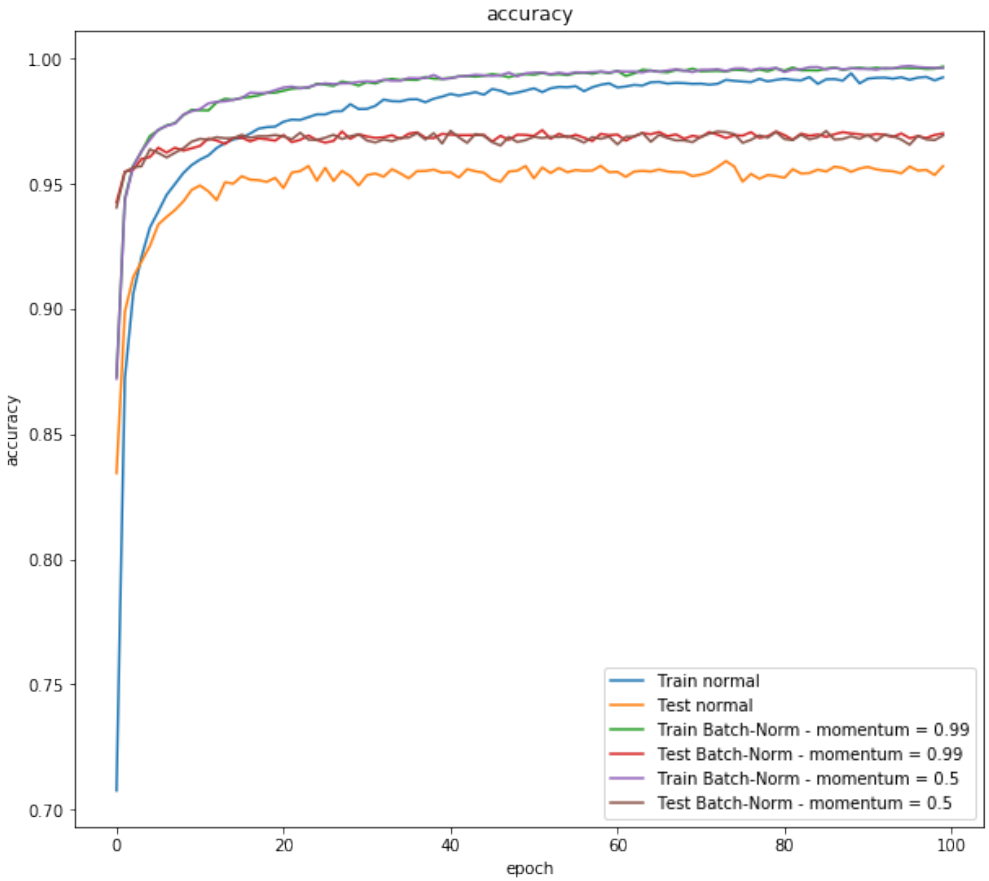
```
Model: "sequential_2"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_8 (Dense)              (None, 40)                31400
_________________________________________________________________
batch_normalization_3 (Batch (None, 40)                160
_________________________________________________________________
dense_9 (Dense)              (None, 40)                1640
_________________________________________________________________
batch_normalization_4 (Batch (None, 40)                160
_________________________________________________________________
dense_10 (Dense)             (None, 40)                1640
_________________________________________________________________
batch_normalization_5 (Batch (None, 40)                160
_________________________________________________________________
dense_11 (Dense)             (None, 10)                410
=================================================================
Total params: 35,570
Trainable params: 35,330
Non-trainable params: 240
_________________________________________________________________
```

```
In [16]: history3 = model.fit(x_train, y_train, batch_size = batch, validation_split = 0.3,
                              epochs = epoch, verbose = verbose)
```

```
In [17]: test_loss, test_acc = model.evaluate(x_test,  y_test, verbose=2)

         print('\nTest acccuracy:', test_acc)
```

```
10000/1 - 1s - loss: 0.0753 - accuracy: 0.9714

Test acccuracy: 0.9714
```

```
In [18]: #plot
         plt.figure(figsize=(10,9))
         plt.plot(history1.history['accuracy'])
         plt.plot(history1.history['val_accuracy'])


         plt.plot(history2.history['accuracy'])
         plt.plot(history2.history['val_accuracy'])

         plt.plot(history3.history['accuracy'])
         plt.plot(history3.history['val_accuracy'])

         #plt.plot(history4.history['accuracy'])
         #plt.plot(history4.history['val_accuracy'])

         plt.legend(['Train normal', 'Test normal',
                     'Train Batch-Norm - momentum = 0.99', 'Test Batch-Norm - momentum = 0.99',
                     'Train Batch-Norm - momentum = 0.5', 'Test Batch-Norm - momentum = 0.5',
                     'Train Batch-Norm antes act - momentum = 0.99', 'Test Batch-Norm antes act -

         plt.title('accuracy')
         plt.ylabel('accuracy')
         plt.xlabel('epoch')

         plt.show()
```



- Experimentar con diferentes valores y parámetros
- Experimentar con diferente arquitectura