Clasificaci?n con red neuronal

June 28, 2016

```
In [11]: %pylab inline
         import numpy as np
         import pandas as pd

         from keras.models import Sequential
         from keras.layers import Dense, Activation
         from keras.regularizers import l1

         import pyprind
```

```
Populating the interactive namespace from numpy and matplotlib
```

1 Loading data

```
In [2]: data_train = pd.read_csv('UCI HAR Dataset/train/train.csv')
        data_test  = pd.read_csv('UCI HAR Dataset/test/test.csv')
```

```
In [3]: X_train = data_train.iloc[:, 1:-6]
        Y_train = data_train.iloc[:,-6:]

        X_test = data_test.iloc[:, 1:-6]
        Y_test = data_test.iloc[:,-6:]
```

```
In [4]: X_train.shape
```

```
Out[4]: (7352, 561)
```

```
In [5]: np_X_train = X_train.as_matrix()
        np_Y_train = Y_train.as_matrix()

        np_X_test = X_test.as_matrix()
        np_Y_test = Y_test.as_matrix()
```

2 Creating the model

```
In [7]: def create_model(p=None):
            """
            Creates a model based on parameters `p`.

            Example:

                p = {'hidden': [64,32],
                     'activation_func': 'tanh', #'relu', 'tanh',
```

```
            'l1_reg': 0.01,
            'optimizer_method': 'SGD'} #'SGD', 'adadelta'

        model = create_model(p)

    """

    if p==None:
        p = {'hidden': [32],
             'activation_func': 'tanh',
             'l1_reg': 0.01,
             'optimizer_method': 'SGD'}
    hidden = p.get('hidden', [32])
    activation_func = p.get('activation_func', 'tanh')
    l1_reg = p.get('l1_reg', 0.01)
    optimizer_method = p.get('optimizer_method', 'SGD')

    model = Sequential()
    model.add(Dense(hidden[0],
                    input_dim=561,
                    activation=activation_func,
                    W_regularizer=l1(l1_reg)))
    hidden = hidden[1:]
    for h in hidden:
        model.add(Dense(h, activation=activation_func, W_regularizer=l1(l1_reg)))

    model.add(Dense(6, activation='softmax'))

    model.compile(loss='categorical_crossentropy', optimizer=optimizer_method, metrics=['accura

    return model
```

3 Training

3.0.1 Cross-validation

```
In [8]: def cross_validation(X,Y, k=10, nn_p=None, verboise=True):
            """
            Runs a k-folded cross validation over a training set. Returns the classification error obta

            Example:

                error = cross_validation(np_X_train, np_Y_train)

            """

            if nn_p==None:
                nn_p = {'hidden': [32],
                        'activation_func': 'tanh', #'relu', 'tanh',
                        'l1_reg': 0.01,
                        'optimizer_method': 'SGD', #'SGD', 'adadelta'
                        'epochs': 10} #Not used in this example, but in cross-validation.
            hidden = nn_p.get('hidden', [32])
            activation_func = nn_p.get('activation_func', 'tanh')
```

```
    l1_reg = nn_p.get('l1_reg', 0.01)
    optimizer_method = nn_p.get('optimizer_method', 'SGD')
    epochs = nn_p.get('epochs', 10)

    groups = np.random.choice(X.shape[0],X.shape[0], replace=False) % k

    classification_error = []
    if verboise:
        print("{}-folded cross-validation:".format(k))
        bar = pyprind.ProgBar(k)

    for i in xrange(k):
        i_train = groups!=i
        i_test = groups==i

        model = create_model(nn_p)
        training_results = model.fit(X[i_train,:], Y[i_train,:],
                                     validation_data=(X[i_test,:],Y[i_test,:]),
                                     nb_epoch=epochs,
                                     verbose=0)
        classification_error.append(1 - training_results.history['val_acc'][-1])
        if verboise: bar.update()

    classification_error = mean(classification_error)
    if verboise: print("{}-folded cross-validation classification error: {}".format(k, classifi

    return classification_error
```

3.0.2 Grid search

```
In [9]: def grid_search(data,
                       hiddens=None, l1_regs=None, activation_func=None, optimizer_method=None, epochs=
                       cv_groups=10):
    """
    Runs a grid search using cross-validation over the hyper-parameters passed. Returns
    classification error for each configuration.

    Example:

        hiddens = [[10], [32]]
        l1_regs = [1, 0]
        grid_search_results = grid_search((np_X_train, np_Y_train),
                                          hiddens=hiddens, l1_regs=l1_regs,
                                          cv_groups=2)

    """
    if hiddens==None: hiddens=[32]
    if l1_regs==None: l1_regs=[0.01]
    if activation_func==None: activation_func=['tanh']
    if optimizer_method==None: optimizer_method=['SGD']
    if epochs==None: epochs=[10]

    grid = [{'hidden':a,
             'l1_reg':b,
```

```
                    'activation_func':c,
                    'optimizer_method':d,
                    'epochs':e}
                   for a in hiddens
                   for b in l1_regs
                   for c in activation_func
                   for d in optimizer_method
                   for e in epochs]

        bar = pyprind.ProgBar(len(grid))
        for p in grid:
            p['classification_error'] = cross_validation(data[0], data[1], nn_p=p, k=cv_groups, verb
            bar.update()

        return grid
```

```
In [12]: # Hacemos una grid search
         hiddens = [[64,32], [32,10], [10,5], [64], [32], [10]]
         l1_regs = [1, 1e-1, 1e-2, 1e-3, 1e-4, 0]
         activation_func = ['tanh']
         optimizer_method = ['SGD', 'adadelta']
         epochs = [10]

         grid_search_results = grid_search((np_X_train, np_Y_train),
                                           hiddens=hiddens,
                                           l1_regs=l1_regs,
                                           activation_func=activation_func,
                                           optimizer_method=optimizer_method,
                                           epochs=epochs,
                                           cv_groups=2)
         print(grid_search_results)

         # Elegimos el mejor modelo
         best_params = {}
         for m in grid_search_results:
             if m['classification_error'] < best_params.get('classification_error', np.inf):
                 best_params = m
         print(best_params)
```

```
0%                          100%
[##############################] | ETA: 00:00:00

[{'activation_func': 'tanh', 'epochs': 10, 'optimizer_method': 'SGD', 'l1_reg': 1, 'hidden': [64, 32], '
{'activation_func': 'tanh', 'epochs': 10, 'optimizer_method': 'adadelta', 'l1_reg': 0.0001, 'hidden': [6

Total time elapsed: 00:43:51
```

```
In [13]: d = [{'activation_func': 'tanh', 'epochs': 10, 'optimizer_method': 'SGD', 'hidden': [64, 32],
```

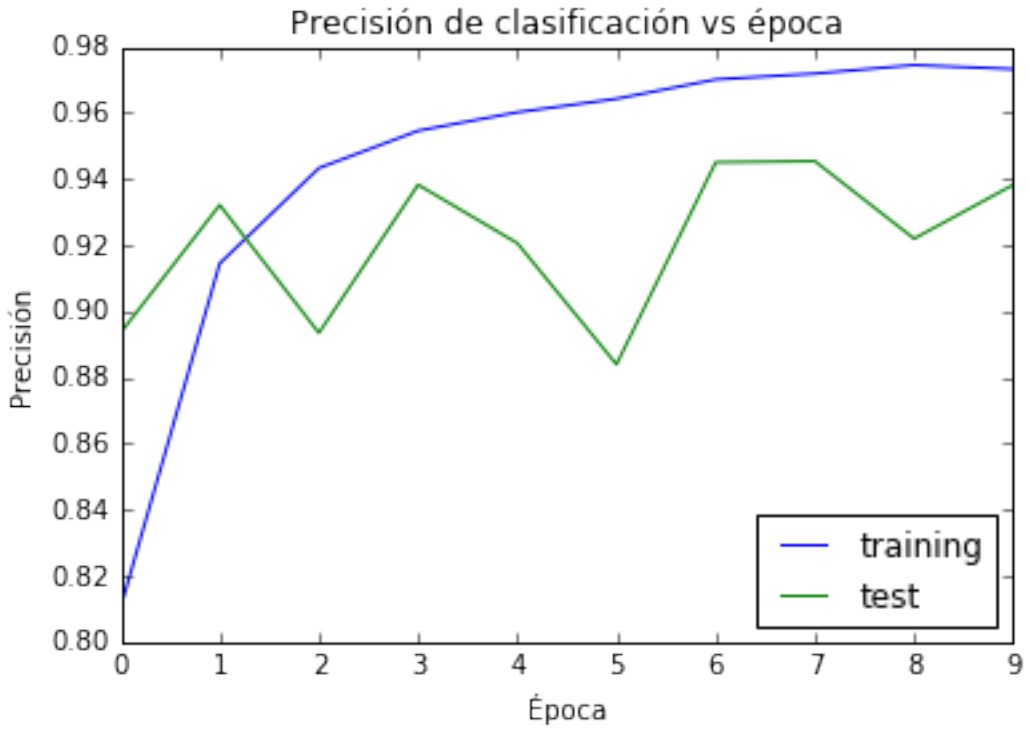
3.0.3 Entrenamiento del modelo final

```
In [14]: model = create_model(best_params)
         training_results = model.fit(np_X_train, np_Y_train,
                                      validation_data=(np_X_test, np_Y_test),
                                      nb_epoch=10)
```

```
Train on 7352 samples, validate on 2947 samples
Epoch 1/10
7352/7352 [==============================] - 3s - loss: 0.8128 - acc: 0.8104 - val_loss: 0.3914 - val_ac
Epoch 2/10
7352/7352 [==============================] - 2s - loss: 0.4567 - acc: 0.9144 - val_loss: 0.2308 - val_ac
Epoch 3/10
7352/7352 [==============================] - 2s - loss: 0.3675 - acc: 0.9433 - val_loss: 0.2580 - val_ac
Epoch 4/10
7352/7352 [==============================] - 2s - loss: 0.3203 - acc: 0.9546 - val_loss: 0.1705 - val_ac
Epoch 5/10
7352/7352 [==============================] - 2s - loss: 0.2970 - acc: 0.9601 - val_loss: 0.2073 - val_ac
Epoch 6/10
7352/7352 [==============================] - 2s - loss: 0.2773 - acc: 0.9642 - val_loss: 0.2663 - val_ac
Epoch 7/10
7352/7352 [==============================] - 2s - loss: 0.2612 - acc: 0.9701 - val_loss: 0.1400 - val_ac
Epoch 8/10
7352/7352 [==============================] - 2s - loss: 0.2495 - acc: 0.9718 - val_loss: 0.1389 - val_ac
Epoch 9/10
7352/7352 [==============================] - 2s - loss: 0.2358 - acc: 0.9744 - val_loss: 0.1907 - val_ac
Epoch 10/10
7352/7352 [==============================] - 2s - loss: 0.2314 - acc: 0.9732 - val_loss: 0.1569 - val_ac
```

In [15]:
```
pylab.plot(training_results.epoch, training_results.history['acc'], label='training')
pylab.plot(training_results.epoch, training_results.history['val_acc'], label='test')
pylab.legend(loc='lower right')
pylab.xlabel(u"Época")
pylab.ylabel(u"Precisión")
pylab.title(u"Precisión de clasificación vs época")
```

Out[15]:
```
<matplotlib.text.Text at 0x7fe455a3b5d0>
```



4 Evaluating models

```
In [37]: error = 1 - model.evaluate(np_X_train, np_Y_train)[1]
         print("\nE_in = {}".format(error))
```

```
7328/7352 [============================>.] - ETA: 0s
E_in = 0.0214907508161
```

```
In [38]: error = 1 - model.evaluate(np_X_test, np_Y_test)[1]
         print("\nE_test = {}".format(error))
```

```
2912/2947 [============================>.] - ETA: 0s
E_test = 0.061757719715
```

```
In [41]: from sklearn.metrics import confusion_matrix
         classes = model.predict_classes(np_X_test)
         print "\nMatriz de confusión:"
         print confusion_matrix(np.argmax(np_Y_test,axis=1), classes).tolist()
```

```
2912/2947 [============================>.] - ETA: 0s
Matriz de confusión:
[[526, 0, 11, 0, 0, 0], [0, 393, 96, 0, 0, 2], [0, 14, 518, 0, 0, 0], [0, 0, 0, 482, 9, 5], [0, 0, 0, 4
```