Notebook

November 23, 2017

1 Importação de módulos

In [1]:
```
%matplotlib inline
import random
import seaborn as sn
import numpy as np
import matplotlib.pyplot as plt
from sklearn import model_selection, metrics
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import OneHotEncoder
import tensorflow as tf
from keras import backend as K
import psutil
import os
from keras.models import Sequential
from keras.layers import Dense, Activation
from keras.utils import np_utils
K.set_image_dim_ordering('th')
import time

num_cores = psutil.cpu_count()
GPU= True

if GPU:
    num_GPU = 1
    num_CPU = 1
    print('Usando a GPU')
else:
    num_CPU = 1
    num_GPU = 0
    print('Usando apenas o CPU')

config = tf.ConfigProto(intra_op_parallelism_threads=num_cores,\
        inter_op_parallelism_threads=num_cores, allow_soft_placement=True,\
        device_count = {'CPU' : num_CPU, 'GPU' : num_GPU})
session = tf.Session(config=config)
K.set_session(session)
```

```
Using TensorFlow backend.
```

```
Usando a GPU
```

2 Tratamento de Dados

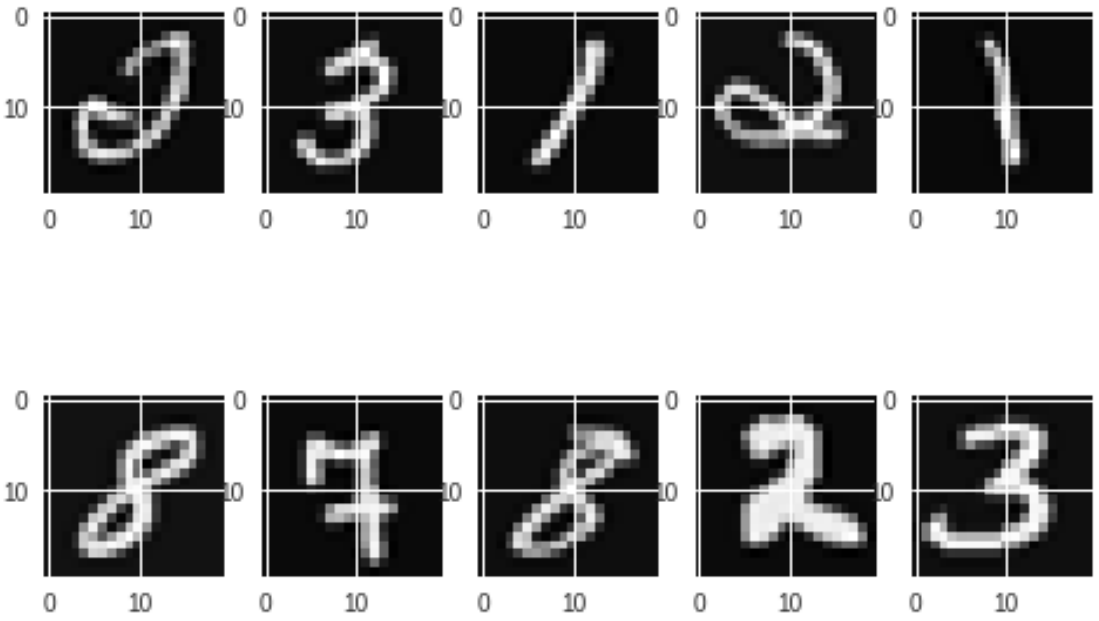
2.0.1 Carregamento de dados

Os dados são treinados são carregados, separando-se entre os dados contendo features e labels. Os dados de imagens são rotacionados para ficarem na posição correta.

In [2]:
```
mnist = np.loadtxt('../data/exdata.csv', delimiter=',')

data = mnist[:-1].T
data = np.array(list(map(lambda d: d.reshape((20,20)).T.flatten(), data)))
target = mnist[-1]

target[target == 10] = 0
```

2.0.2 Exemplos de imagens do conjunto de dados

In [3]:
```
rows = 2
cols = 5
f, axarr = plt.subplots(rows, cols)
for r in range(rows):
    for c in range(cols):
        rand_data = random.choice(data)
        axarr[r, c].imshow(rand_data.reshape((20,20)), cmap=plt.get_cmap('gray'))
```



2.0.3 Normalização de dados

A saída é normalizada através do OneHotEncoder, que transforma o valor do target em um vetor de zeros e valor 1 no índicie correspondente ao valor do target

```
In [4]: target_scaler = OneHotEncoder()
        target_normalized = target_scaler.fit_transform(target.reshape((-1, 1))).todense()
```

2.0.4 Separação de dados treinano/teste

15% dos dados serão separados para teste

```
In [6]: data_train, data_test, target_train, target_test = train_test_split(
            data,
            target_normalized,
            train_size=(85/100),
        )
```

2.1 Definição da arquitetura

Camada
entrada
hidden layer
saída

```
In [7]: def mlp():
            model = Sequential()
            model.add(Dense(205, input_dim=400, kernel_initializer="normal"))
            model.add(Activation('relu'))
            model.add(Dense(10, kernel_initializer="normal"))
            model.add(Activation('softmax'))
            model.compile(loss='categorical_crossentropy', optimizer='adam', metrics=['accuracy'
            return model
```

2.2 Treinamento da rede

```
In [8]: model = mlp()

        start_time = time.time()

        treinar = True
        if treinar:
            print("Treinando a rede")
            model.fit(data_train,
```

```
                        target_train,
                        validation_data=(data_test, target_test),
                        epochs=100,
                        batch_size=150,
                        verbose=0
                       )
            model.save_weights("mlp.h5")
            print("Pesos salvos")
        else:
            model.load_weights("mlp.h5")
            print("Pesos recuperados do disco")

        scores = model.evaluate(data_test, target_test, verbose=0)

        print("Baseline Error: %.2f%%" % (100-scores[1]*100))
        print("Rede treinada/buscada em %.2f segundos" % (time.time() - start_time))
```

```
Treinando a rede
Pesos salvos
Baseline Error: 6.00%
Rede treinada/buscada em 17.76 segundos
```

2.3 Resultados

Teste Utilizando Todos os Dados

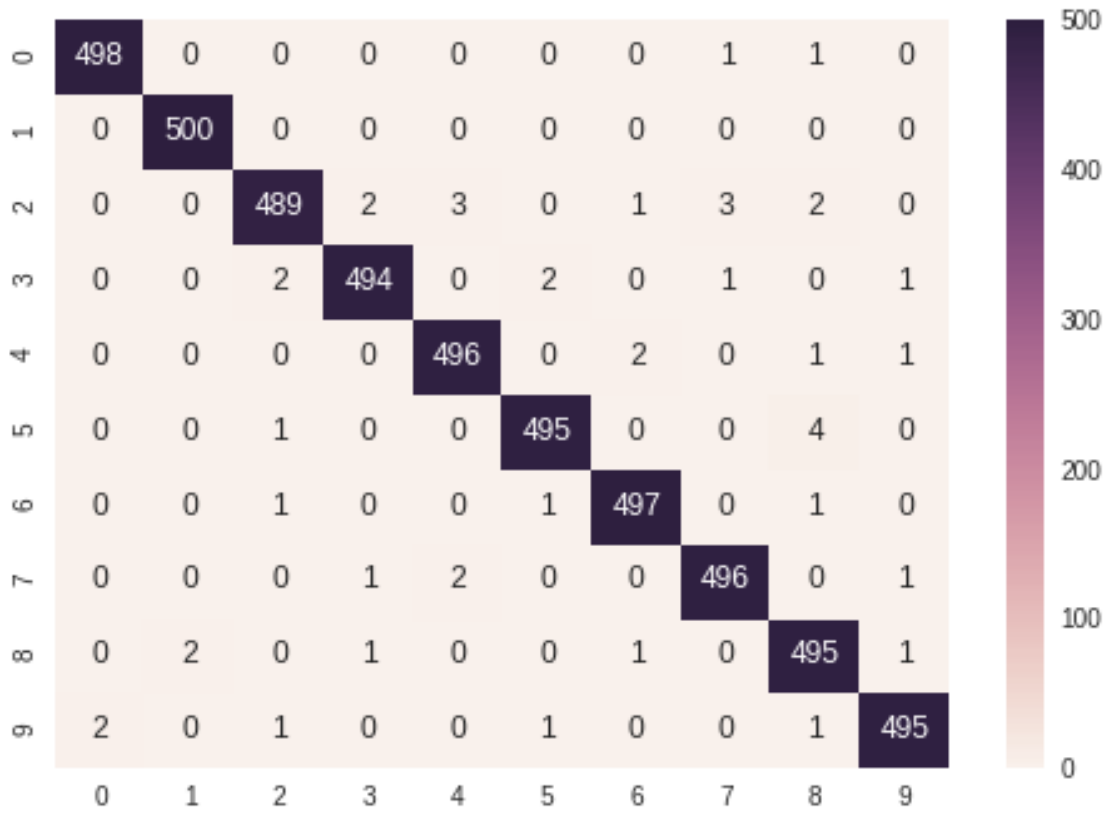
```
In [9]: predictions_all = model.predict(data)
        predictions_all = np.argmax(predictions_all, axis=1)
        print("Test set accuracy: {:.2%}".format(
            metrics.accuracy_score(target, predictions_all)))
```

```
Test set accuracy: 99.10%
```

Matriz de confusão para todo o conjunto de dados.

```
In [10]: confusion_matrix = metrics.confusion_matrix(target, predictions_all)
         sn.heatmap(confusion_matrix, annot=True, fmt='d')
```

```
Out[10]: <matplotlib.axes._subplots.AxesSubplot at 0x7fb79a333390>
```




```
In [11]: print(metrics.classification_report(target, predictions_all))
```

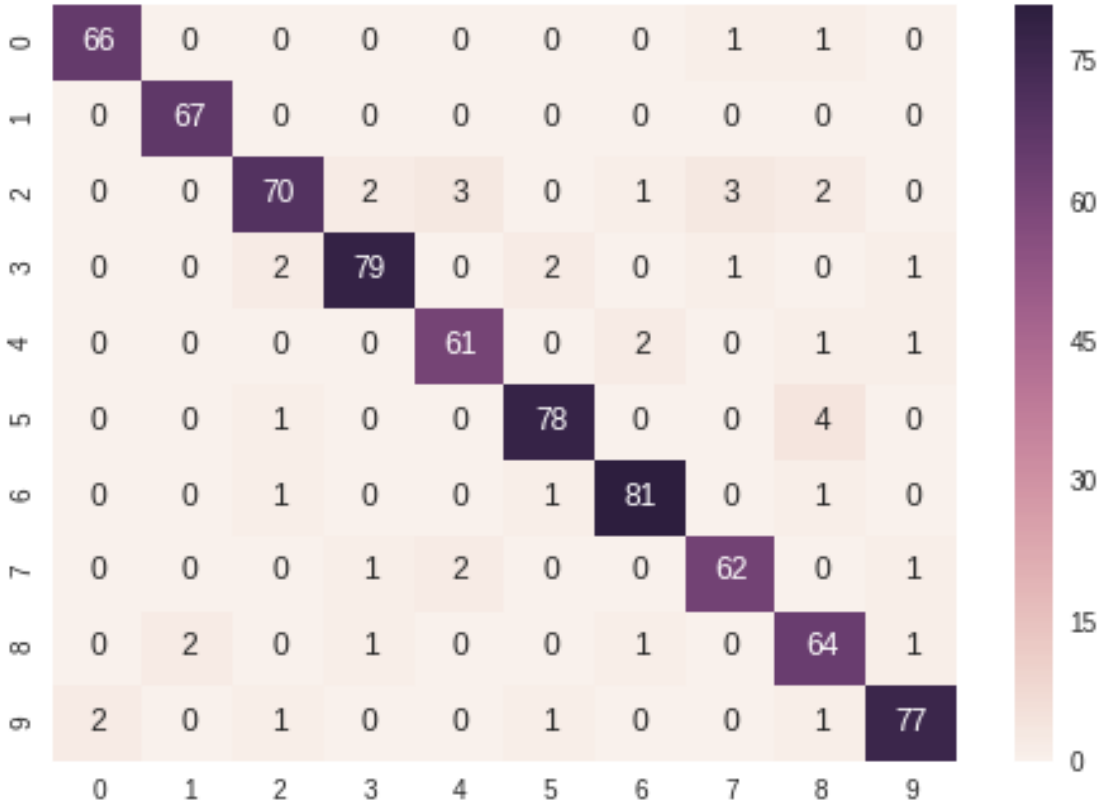
	precision	recall	f1-score	support
0.0	1.00	1.00	1.00	500
1.0	1.00	1.00	1.00	500
2.0	0.99	0.98	0.98	500
3.0	0.99	0.99	0.99	500
4.0	0.99	0.99	0.99	500
5.0	0.99	0.99	0.99	500
6.0	0.99	0.99	0.99	500
7.0	0.99	0.99	0.99	500
8.0	0.98	0.99	0.99	500
9.0	0.99	0.99	0.99	500
avg / total	0.99	0.99	0.99	5000

Teste Utilizando Apenas o Conjunto de Teste

```
In [12]: predictions = model.predict(data_test)
         predictions = np.argmax(predictions, axis=1)
         target_test_classes = np.asarray(target_test.argmax(axis=1)).reshape(-1)
         print("Test set accuracy: {:.2%}".format(
             metrics.accuracy_score(target_test_classes, predictions)))

Test set accuracy: 94.00%
```

Matriz de confusão para o conjunto teste.

```
In [13]: confusion_matrix = metrics.confusion_matrix(target_test_classes, predictions)
         sn.heatmap(confusion_matrix, annot=True, fmt='d')

Out[13]: <matplotlib.axes._subplots.AxesSubplot at 0x7fb79a333940>
```

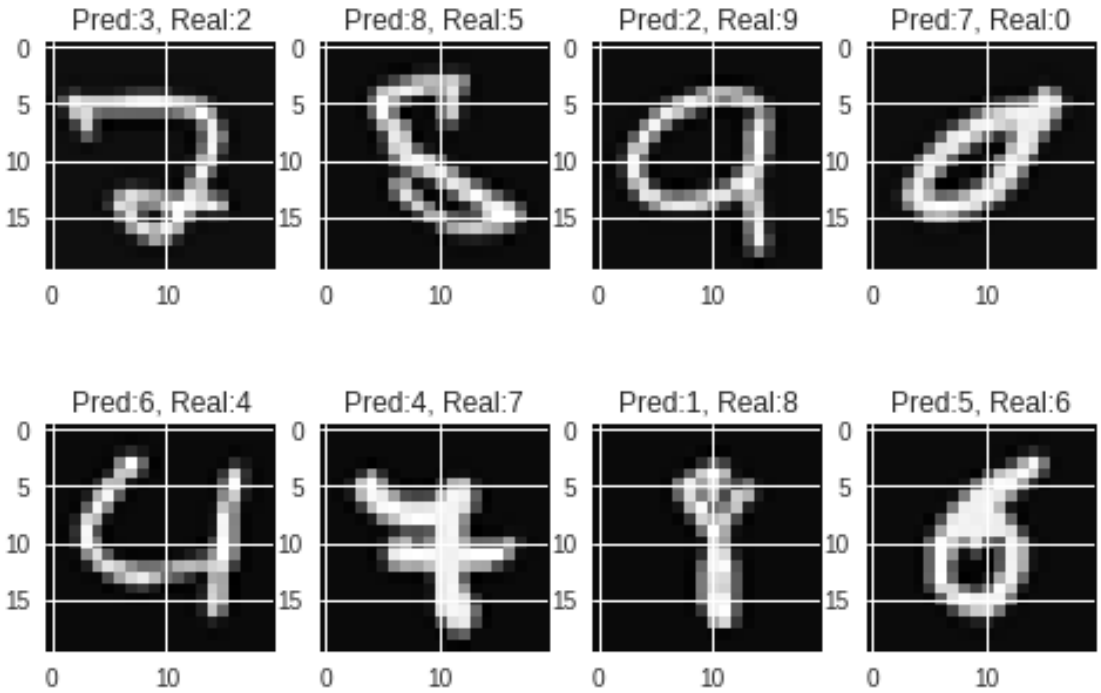



```
In [14]: print(metrics.classification_report(target_test_classes, predictions))

              precision    recall  f1-score   support

           0       0.97      0.97      0.97        68
           1       0.97      1.00      0.99        67
```

```
             2       0.93      0.86      0.90        81
             3       0.95      0.93      0.94        85
             4       0.92      0.94      0.93        65
             5       0.95      0.94      0.95        83
             6       0.95      0.96      0.96        84
             7       0.93      0.94      0.93        66
             8       0.86      0.93      0.90        69
             9       0.95      0.94      0.94        82

avg / total       0.94      0.94      0.94       750
```

2.3.1 Alguns erros de classificação

```
In [15]: wrong_class = [i for i in range(predictions.size) if predictions[i]!=target_test_classe
         rows = 2
         cols = 4
         f, axarr = plt.subplots(rows, cols)
         for r in range(rows):
             for c in range(cols):
                 rand_i = random.choice(wrong_class)
                 axarr[r, c].imshow(data_test[rand_i].reshape((20,20)), cmap=plt.get_cmap('gray'
                 axarr[r, c].set_title('Pred:{}, Real:{}'.format(predictions[rand_i],
                                                                 target_test_classes[rand_i]))
```



3 Classificação de novos dados

In [16]:
```
from PIL import Image
import matplotlib.image as mpimg
from resizeimage import resizeimage


with open('5.png', 'r+b') as f:
    with Image.open(f) as image:
        cover = resizeimage.resize_cover(image, [20, 20]).convert('L')
        cover.save('5inho.png', image.format)
with open('7.png', 'r+b') as f:
    with Image.open(f) as image:
        cover = resizeimage.resize_cover(image, [20, 20]).convert('L')
        cover.save('7inho.png', image.format)
img5 = mpimg.imread('5inho.png').flatten()
img7 = mpimg.imread('7inho.png').flatten()
img = np.vstack((img5,img7))
y = model.predict(img)
output = y.argmax(axis=1)
print(y[0][output])
print(output)
f, axarr = plt.subplots(1, 2)
axarr[0].imshow(img5.reshape((20,20)), cmap=plt.get_cmap('gray'))
axarr[1].imshow(img7.reshape((20,20)), cmap=plt.get_cmap('gray'))
```

```
[ 0.83503062  0.05407155]
[5 3]
```

Out[16]: <matplotlib.image.AxesImage at 0x7fb776bc2400>