test1_lr_001_ep_5000

April 29, 2020

0.1 Importando os pacotes

[2]:

```
import matplotlib.pyplot as plt
%matplotlib inline
import numpy as np
import pandas as pd
import glob
import os
import h5py

from sklearn.preprocessing import minmax_scale
from skimage import img_as_ubyte
from skimage.transform import resize
from sklearn.metrics import confusion_matrix, accuracy_score, cohen_kappa_score
from sklearn.model_selection import train_test_split

from keras.layers import Conv3D, MaxPool3D, Flatten, Dense
from keras.layers import Dropout, Input, BatchNormalization
from keras.utils import to_categorical
from keras.losses import categorical_crossentropy
from keras.optimizers import Adadelta
from keras.models import load_model
from keras.models import Model
from keras.callbacks import ModelCheckpoint
from keras.regularizers import l2
from keras import regularizers

import tensorflow as tf
```

0.2 Converter uint8

[3]:

```
def scaler_uint8(image):
    shape = image.shape
    image_scaled = minmax_scale(image.ravel(), feature_range=(0,255)).
 ↪reshape(shape).astype(np.uint8)
    return image_scaled
```

1 Lendo a base .npy

[4]:

```
def lendo_img_npy(paths):
    slices = [resize(np.load(s), (16, 16, 16, 1), preserve_range=True) for s in␣
 ↪paths]
    return scaler_uint8(np.array(slices))
```

2 Lendo imagens (treino) - Nódulos -> Benigno e Maligno

[5]:

```
def lendo_conjunto_all(path_benigno, path_maligno):
    # Benigno
    path_b = glob.glob(path_benigno)
    images_b_npy = lendo_img_npy(path_b)
    # Maligno
    path_m = glob.glob(path_maligno)
    images_m_npy = lendo_img_npy(path_m)
    return(images_b_npy, images_m_npy)
```

3 Lendo imagens - Nódulos -> Benigno e Maligno

[6]:

```
path_treino_b = '../../dataset/training/benigno/*.npy'
path_valid_b = '../../dataset/validation/benigno/*.npy'
path_teste_b = '../../dataset/test/benigno/*.npy'

path_treino_m = '../../dataset/training/maligno/*.npy'
path_valid_m = '../../dataset/validation/maligno/*.npy'
path_teste_m = '../../dataset/test/maligno/*.npy'

treino_benigno, treino_maligno = lendo_conjunto_all(path_treino_b,␣
 ↪path_treino_m)
valid_benigno, valid_maligno = lendo_conjunto_all(path_valid_b, path_valid_m)
teste_benigno, teste_maligno = lendo_conjunto_all(path_teste_b, path_teste_m)
```

3.1 Image Type

[7]:

```
image = teste_benigno[0].copy()
print('Type: ', image.dtype)
print('Max: ', np.amax(image))
print('Min: ', np.amin(image))
```

```
Type:  uint8
Max:  253
```

```
Min:  0
```

4 Gerando os labels (Treino)

[8]:

```python
labels_treino_0 = np.zeros((treino_benigno.shape[0])).astype(np.int)
print('Treino Benigno: ', len(labels_treino_0))
labels_treino_1 = np.ones((treino_maligno.shape[0])).astype(np.int)
print('Treino Maligno: ', len(labels_treino_1))
labels_treino = np.concatenate((labels_treino_0, labels_treino_1))
print('Tamanho do conjunto de treino:', len(labels_treino))
```

```
Treino Benigno:  668
Treino Maligno:  271
Tamanho do conjunto de treino: 939
```

5 Gerando os labels (Validação)

[9]:

```python
labels_val_0 = np.zeros((valid_benigno.shape[0])).astype(np.int)
print('Validação Benigno : ', len(labels_val_0))
labels_val_1 = np.ones((valid_maligno.shape[0])).astype(np.int)
print('Validação Maligno : ', len(labels_val_1))
labels_valid = np.concatenate((labels_val_0, labels_val_1))
print('Tamanho do conjunto de validação:', len(labels_valid))
```

```
Validação Benigno :  96
Validação Maligno :  39
Tamanho do conjunto de validação: 135
```

6 Gerando os labels (Teste)

[10]:

```python
labels_teste_0 = np.zeros((teste_benigno.shape[0])).astype(np.int)
print('Teste Benigno : ', len(labels_teste_0))
labels_teste_1 = np.ones((teste_maligno.shape[0])).astype(np.int)
print('Teste Maligno : ', len(labels_teste_1))
labels_teste = np.concatenate((labels_teste_0, labels_teste_1))
print('Tamanho do conjunto de teste:', len(labels_teste))
```

```
Teste Benigno :  192
Teste Maligno :  79
Tamanho do conjunto de teste: 271
```

7 Concatenar (Treino e Teste)

[11]:
```
base_train = np.concatenate((treino_benigno, treino_maligno))
print('Shape das imagens de treino concatenada:', base_train.shape)

base_valid = np.concatenate((valid_benigno, valid_maligno))
print('Shape das imagens de validação concatenada:', base_valid.shape)

base_teste = np.concatenate((teste_benigno, teste_maligno))
print('Shape das imagens de teste concatenada:', base_teste.shape)
```

```
Shape das imagens de treino concatenada: (939, 16, 16, 16, 1)
Shape das imagens de validação concatenada: (135, 16, 16, 16, 1)
Shape das imagens de teste concatenada: (271, 16, 16, 16, 1)
```

8 Embaralhar conjunto (Treino e Teste)

[12]:
```
treino1, treino2 , labels_treino1, labels_treino2 =␣
 ↪train_test_split(base_train, labels_treino, test_size = 0.5, random_state=42)
x_train = np.concatenate((treino1, treino2))
y_train = np.concatenate((labels_treino1, labels_treino2))
print(x_train.shape)
```

```
(939, 16, 16, 16, 1)
```

[13]:
```
valid1, valid2 , labels_valid1, labels_valid2 = train_test_split(base_valid,␣
 ↪labels_valid, test_size = 0.5, random_state=42)
x_valid = np.concatenate((valid1, valid2))
y_valid = np.concatenate((labels_valid1, labels_valid2))
print(x_valid.shape)
```

```
(135, 16, 16, 16, 1)
```

[14]:
```
teste1, teste2 , labels_teste1, labels_teste2 = train_test_split(base_teste,␣
 ↪labels_teste, test_size = 0.5, random_state=42)
x_test = np.concatenate((teste1, teste2))
y_test = np.concatenate((labels_teste1, labels_teste2))
print(x_test.shape)
```

```
(271, 16, 16, 16, 1)
```

8.1 Normalização (Treino, Validação e Teste)

[15]:
```
x_train = x_train / 255.
x_valid = x_valid / 255.
x_test = x_test / 255.
```

8.2 Imagens normalizadas

[16]:
```
image = x_test[4].copy()
print('Type: ', image.dtype)
print('Max: ', np.amax(image))
print('Min: ', np.amin(image))
```

```
Type:  float64
Max:  0.996078431372549
Min:  0.0
```

9 Convert target variable into one-hot

[17]:
```
y_train = to_categorical(y_train, 2)
y_valid = to_categorical(y_valid, 2)
y_test = to_categorical(y_test, 2)
```

10 Selected GPU

[18]:
```
os.environ["CUDA_DEVICE_ORDER"]="PCI_BUS_ID";  # The GPU id to use, usually␣
 ↪either "0" or "1";
os.environ["CUDA_VISIBLE_DEVICES"]="0";  # Do other imports now...
```

10.1 Camada de Entrada

[19]:
```
# input layer
img_input = Input((16, 16, 16, 1))

x = Conv3D(8, (3, 3 ,3), activation='relu', padding='same',␣
 ↪name='block1_conv1', kernel_regularizer=regularizers.l2(0.0001))(img_input)
x = Conv3D(16, (3, 3 ,3), activation='relu', padding='same',␣
 ↪name='block1_conv2', kernel_regularizer=regularizers.l2(0.0001))(x)
x = MaxPool3D((2, 2, 2), strides=(2, 2, 2), name='block1_pool')(x)

pooling_layer2 = BatchNormalization()(x)
flatten_layer = Flatten()(pooling_layer2)
```

```
dense_layer1 = Dense(units=256, activation='relu', name='fc1',␣
 ↪kernel_regularizer=regularizers.l2(0.0001))(flatten_layer)
dense_layer1 = Dropout(0.4)(dense_layer1)
dense_layer2 = Dense(units=128, activation='relu', name='fc2',␣
 ↪kernel_regularizer=regularizers.l2(0.0001))(dense_layer1)
dense_layer2 = Dropout(0.4)(dense_layer2)
##Informar a quantidade de categoria
output_layer = Dense(units=2, activation='softmax',␣
 ↪name='predictions')(dense_layer2)

## define o modelo com a camada de entrada e a de saída
model = Model(inputs=img_input, outputs=output_layer)
```

[20]:

```
model.summary()
```

```
Model: "model_1"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
input_1 (InputLayer)         (None, 16, 16, 16, 1)     0
_________________________________________________________________
block1_conv1 (Conv3D)        (None, 16, 16, 16, 8)     224
_________________________________________________________________
block1_conv2 (Conv3D)        (None, 16, 16, 16, 16)    3472
_________________________________________________________________
block1_pool (MaxPooling3D)   (None, 8, 8, 8, 16)       0
_________________________________________________________________
batch_normalization_1 (Batch (None, 8, 8, 8, 16)       64
_________________________________________________________________
flatten_1 (Flatten)          (None, 8192)              0
_________________________________________________________________
fc1 (Dense)                  (None, 256)               2097408
_________________________________________________________________
dropout_1 (Dropout)          (None, 256)               0
_________________________________________________________________
fc2 (Dense)                  (None, 128)               32896
_________________________________________________________________
dropout_2 (Dropout)          (None, 128)               0
_________________________________________________________________
predictions (Dense)          (None, 2)                 258
=================================================================
Total params: 2,134,322
Trainable params: 2,134,290
Non-trainable params: 32
_________________________________________________________________
```

10.2 Treinando o modelo

[ ]:

```
checkpoint = ModelCheckpoint("model_history_t1/best_model_test1_lr_001_ep_5000.
 ↪h5", monitor='val_loss', verbose=1,
    save_best_only=True, mode='auto', period=1)

model.compile(loss=categorical_crossentropy, optimizer=Adadelta(lr=0.001,␣
 ↪decay=0.0001), metrics=['acc'])

hist = model.fit(x=x_train,
                 y=y_train,
                 batch_size=128,
                 epochs=5000,
                 validation_data=(x_valid, y_valid),
                 callbacks=[checkpoint])
model.save("model_history_t1/model_test1_lr_001_ep_5000.h5.h5")
np.save('./model_history_t1/history_model_test1_lr_001_ep_5000', hist)
```

10.3 Predição

[21]:

```
def accuracy(x, y, modelo, name):
    print('\n', name)
    pred = modelo.predict(x)
    pred = np.argmax(pred, axis=1)
    real = np.argmax(y, axis=1)
    print('Matriz de confusão:\n', confusion_matrix(real, pred))
    print('Acurácia:', accuracy_score(real, pred))
    print('Kappa: ', cohen_kappa_score(real, pred))

# accuracy(x_train, y_train, model, 'Treino:')
# accuracy(x_valid, y_valid, model, 'Validação:')
# accuracy(x_test, y_test, model, 'Teste:')
```

10.4 Todas as méticas

[22]:

```
def calc_metric(x, y, modelo):
    #print(y_pred.shape,y_true.shape,np.unique(y_pred),np.unique(y_true))
    pred = modelo.predict(x)
    y_pred = np.argmax(pred, axis=1)
    y_true = np.argmax(y, axis=1)
    cm = confusion_matrix(y_pred.ravel(),y_true.ravel())
    # tn -> Verdeiro Negativo
    # fp -> Falso Positivo
    # fn -> Falso Negativo
    # tp -> Verdadeiro Positivo
    tn, fp, fn, tp = cm.ravel()
    dice = (2.0 * tp) / ((2.0 * tp) + fp + fn)
    jaccard = (1.0 * tp) / (tp + fp + fn)
    sensitivity = (1.0 * tp) / (tp + fn)
    specificity = (1.0 * tn) / (tn + fp)
    accuracy = (1.0 * (tn + tp)) / (tn + fp + tp + fn)
    auc = 1 - 0.5 * (((1.0 * fp) / (fp + tn)) + ((1.0 * fn) / (fn + tp)))
    prec = float(tp)/float(tp + fp)
    fscore = float(2*tp)/float(2*tp + fp + fn)
    kappa = cohen_kappa_score(y_pred, y_true)
    return accuracy, kappa, sensitivity, specificity, auc
```

11 Realizando a predição

[23]:

```
def predict_model(url_model):
    pred_model = load_model(url_model)
    print('\n-------------- Validação ------------------')
    score = pred_model.evaluate(x_valid, y_valid, verbose=0)
    print('loss:', score[0])
    accuracy, kappa, sensitivity, specificity, auc = calc_metric(x_valid,␣
 ↪y_valid, pred_model)
    print('accuracy: ', accuracy)
    print('kappa: ', kappa)
    print('sensitivity: ', sensitivity)
    print('specificity: ', specificity)
    print('auc: ', auc)

    print('\n-------------- Teste ------------------')
    pred_model = load_model(url_model)
    score = pred_model.evaluate(x_test, y_test, verbose=0)
    print('loss:', score[0])
    accuracy, kappa, sensitivity, specificity, auc = calc_metric(x_test,␣
 ↪y_test, pred_model)
    print('accuracy: ', accuracy)
    print('kappa: ', kappa)
    print('sensitivity: ', sensitivity)
    print('specificity: ', specificity)
    print('auc: ', auc)
```

[ ]:

```
print('\nMelhor Modelo:')
predict_model("model_history_t1/best_model_test1_lr_001_ep_5000.h5")
print('\nModelo Final:')
predict_model("model_history_t1/model_test1_lr_001_ep_5000.h5")
```

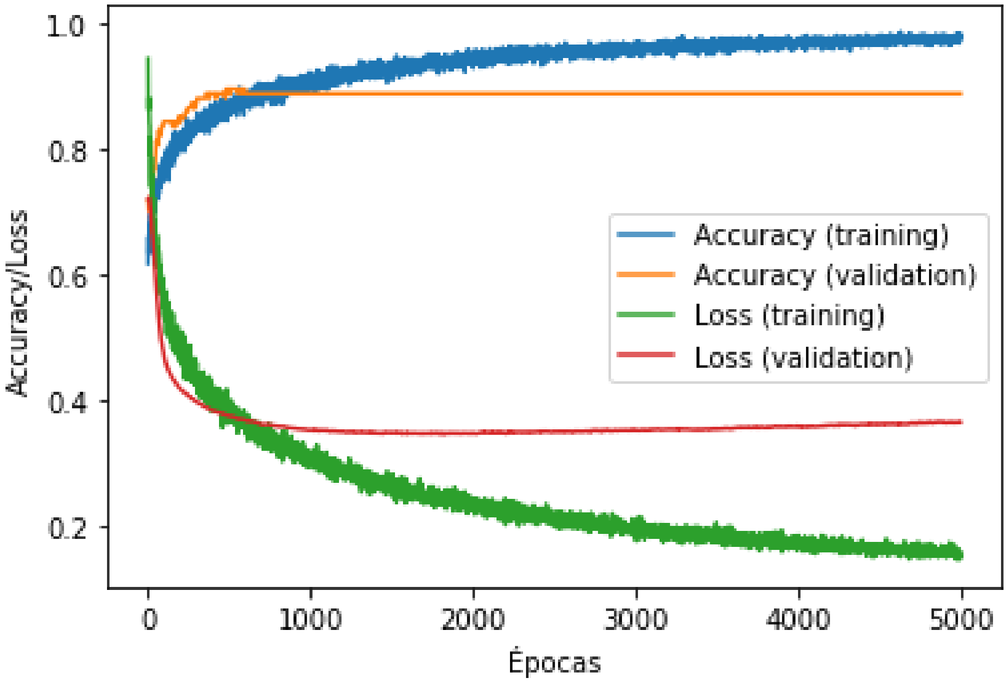
```

Melhor Modelo:
```

```
-------------- Validação ------------------
loss: 0.34714615609910754
accuracy:  0.8888888888888888
kappa:  0.6998666073810582
sensitivity:  0.9615384615384616
specificity:  0.8715596330275229
auc:  0.9165490472829922

-------------- Teste ------------------
```

12 Plotando os gráfico (history), Acurácia e Erro (Treino e Validação)

[39]:

```
def plot_history(hist):
    plt.plot(hist.history["acc"])
    plt.plot(hist.history['val_acc'])
    plt.plot(hist.history['loss'])
    plt.plot(hist.history['val_loss'])
#     plt.title("model accuracy")
    plt.ylabel("Accuracy/Loss")
    plt.xlabel("Épocas")
    plt.legend(["Accuracy (training)","Accuracy (validation)","Loss␣
 ↪(training)","Loss (validation)"])
    plt.savefig('model_history_t1/test1_lr_001_ep_5000.png')
    plt.show()

history = np.load("model_history_t1/history_model_test1_lr_001_ep_5000.
 ↪npy",allow_pickle=True).item()
plot_history(history)
```


1.0
0.8
0.6
0.4
0.2
Accuracy/Loss
0
1000
2000
3000
4000
5000
Épocas
Accuracy (training)
Accuracy (validation)
Loss (training)
Loss (validation)

```
[ ]:
```