Neurophotonics HW1

1. Write a function that will calculate ΔHbR and ΔHbO over time from given intensity measurements at two wavelengths.
2. Run the function and plot two first channels. Each axis will contain ΔHbR line (blue) and ΔHbO line (red).
3. Plot the Fourier transform of the first channel, from the first file. If “noise” is defined as average of the signal in Fourier domain at Frequencies above 2.5Hz, and “signal” is as the signal strength at heart beat frequency (you should have a peak at that frequency), what is the SNR (Signal to noise ratio)?

Please run this function on two input files attached:

FN_031_V2_Postdose2_Nback.mat

FN_032_V1_Postdose1_Nback.mat

Submission:

A. Link to GitHub (or any other git server) with your code.
B. Word/Pdf document with a printout of the code, plots and answers .

Files structure (relevant fields):

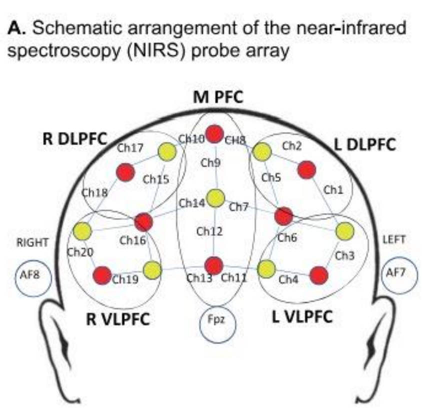
DS: Lambda – two wavelengths [nm]

t: time vector [sec]

d: intensity data : 20 first columns-> 20 channels of first wavelength

20 last columns -> 20 channels of second wavelength

Assume Source-Detector separation length of 3cm.



Function header:

```
function [ dHbR , dHbO, fig ] = CalcNIRS(dataFile, SDS, tissueType, plotChannelIdx,
extinctionCoefficientsFile, DPFperTissueFile, relDPFfile )


%% CalcNIRS - calculate and plot HbR HbO
% Input:
%   dataFile - .mat file with intensity data.
%              DS.Lambda : two wavelengths (in nm)
%                      t : time vector
%                      d : intensity data of 20 channels
%                          20 first rows-> first wavelength, 20 last rows->second wavelength
%  SDS  - Sourse-Detector Separation distance in cm
%  tissueType - one of the rows in DPFperTissueFile (for example 'adult_forearm' \ 'baby_head' \ 'adult_head' \
'adult_leg' )
%  plotChannelIdx - vector with numbers in the range of [1-20] indicating channels to plot. If empty - none is
plotted. (default = [])
%
%  extinctionCoefficientsFile - .csv file with the following columns : wavelength,  Water,  HbO2,   HHb,
FatSoybean
%                                default = '.\ExtinctionCoefficientsData.csv'    (if not passed or empty)
%  DPFperTissueFile - .txt file with two columns: Tissue and DPF  (Tissue is tissue type, corresponding with
tissueType input variable)
%                     measured at 807nm
%                     default = '.\DPFperTissue.txt'       (if not passed or empty)
%  relDPFfile - relative DPF according to wavelength
%              default = '.\RelativeDPFCoefficients.csv'   (if not passed or empty)
%
% Output :
%   dHbR - HbR concentration change for all channels (nx20) where n is time vector length
%   dHbO - HbO concentration change for all channels (nx20) where n is time vector length
%   fig  - handle to figure. Empty if plotChannelIdx==[].
```

Please Check the validity of the input parameters at the beginning of the function (the type, size and values, if the files exist if it’s a filename, the fields names inside the struct).

Extinction coefficients and DPF files are attached:

1. ExtinctionCoefficientsData.csv
2. DPF_per_tissue_at807nm.txt
3. RelativeDPFCoefficients.csv

If you are writing your code in Matlab, use `readtable` function to load these files into Matlab table structure.

Please pay attention that :

"*Molar Extinction Coefficient*" (ε you have seen in the lecture) = "*Specific Absorption Coefficient*"

It's units are $\left[\frac{L}{mol}\frac{1}{cm}\right]$

"Specific Extinction Coefficient" is defined in various ways. In this case it is just

specific extinction coefficient = specific absorption coefficient/ ln(10).

Why to do that?

Usually OD (Optical Density) is defined as $\log_{10}(I_o/I(t))$

So in order to incorporate it in the equation from the lecture:

$$-\ln\left(\frac{I(t)}{I(0)}\right) = \ln\left(\frac{I(0)}{I(t)}\right) = [(\varepsilon_{\mathrm{HbR}}(\lambda).\Delta[\mathrm{HbR}] + \varepsilon_{\mathrm{HbO}}(\lambda).\Delta[\mathrm{HbO}])] \cdot \mathrm{L_{eff}}$$

$$\Downarrow$$

$$\log_{10}\left(\frac{I_0}{I(t)}\right) = \left[\frac{\varepsilon_{HbR}(\lambda)}{ln(10)} \cdot \Delta[HbR] + \frac{\varepsilon_{HbO}(\lambda)}{ln(10)} . \Delta[HbO]\right] \cdot L_{eff}$$

So my recommendation is to calculate the OD ($\log_{10}\left(\frac{I_0}{I(t)}\right)$) , and then use the coefficients in the data file that already include the division by ln(10) ($\frac{\varepsilon_{HbR}(\lambda)}{ln(10)}$).