LAB Master DSAI 2024

The matrix Rva and Ra (in Rva.mat and Ra.mat) contain tensors of 75 patients with Atrial Fibrillation (AF) cardiac pathology.
They consist in 15000 samples of 12 Leads-ECG records order as : I, II, III, aVR, aVL, aVF, V1, V2, V3, V4, V5, V6. The sampling frequency is 256 Hertz.

The ECG in matrix Rva is the raw signals (but band-pass filtered) including ventricular and auricular electrical activities (depolarizations and repolarizations). The ECG in matrix Ra is the modified records where the ventricular activities are removed (complex processing). Only atrial fibrillation signal remains.

All subjects experienced an Electrical Cardioversion to restore sinus rhythm (SR). After a blanking period of 6 months some of them returned to AF (file indrecur.mat) and the rest remained SR (file indnonrecur.mat). Only 63 subjects are documented in indnonrecur and indrecur vectors.

1) Visualisation of the 12 Leads-ECG *(with Matlab)*
2) Simple detection of R waves *(with Matlab)*
3) QRST averaging *(with Matlab)*
4) Ventricular activity substraction : SVD-based *(with Matlab)*

```
%Display first lead (I) and first subject
plot(Xva(1,:,1))
%Display 7th lead (V6) and subject 20
plot(Xva(7,:,20))

%Find the R peaks locations of the first lead (same location for all leads)
and first subject
[PKS,LOCS] = findpeaks((Xva(1,:,1)),'MinPeakHeight',max((Xva(1,:,1)))/2);
figure
%Display first lead (I) and first subject
plot(Xva(1,:,1))
hold on
plot(LOCS,PKS,'o')


%Build the matrix R with all the segments
for   k=2:length(LOCS)-1,R(k-1,:)=Xva(1,LOCS(k)-20:LOCS(k)+min(diff(LOCS))-
21,1);end
hold off
plot(R')
figure
plot(mean(R),'r')

%Example of ventricular activity subtraction on one segment of the first lead
[U,S,V]=svd(R);
plot(diag(S))
M=[V(:,1) V(:,2)];
a=pinv(M)*R(1,:)'

%Display the result of the ventricular activity subtraction on the first
segment. Same method could be applied to all segments of this subject
```

```
plot(R(1,:)'-M*a)


%Segmentation of the Xa matrix with the same time location than for Xva
for    k=2:length(LOCS)-1,Ra(k-1,:)=Xa(1,LOCS(k)-20:LOCS(k)+min(diff(LOCS))-
21,1);end

%Display both results for comparison
Hold off
plot(Ra(1,:)')
hold on
plot(R(1,:)'-M*a)
```

5) Machine learning for AF recurrence classification (applied to Ra) *(student choice for the software, Matlab ?,Tensorflow ?)* → Use only V1 to V6 leads (Ra(7:12,:))
6) ANN for Ventricular activity removal (applied to Rva with learning on Rva and Ra). Ra is supposed to be the ground truth. *(student choice for the software, Tensorflow ?)* → Use only V1 to V6 leads (Ra(7:12,:) and Rva(7:12,:))

If Tensorflow is used, you can load the files and exploit the variable with this example (the path may change):

```
imagesTraining= scio.loadmat("/content/drive/MyDrive/Colab
Notebooks/Data/Xva.mat")
train_images=imagesTraining['Xva']
```