Cours de traitement des signaux biomédicaux
8th Matlab session

Useful commands

svd	singular value decomposition

Additional commands

eigenfilter	eigenfilter design

Remarques

- If the columns of a matrix X contains several signals, their mean can be removed and their variance set to unity using:

```
>> X = X-kron(ones(length(X),1),mean(X,1));
>> X = X./kron(ones(length(X),1),std(X,1));
```

- To estimate the effective rank of a matrix X, use the following commands:

```
>> s = svd(X,0)
>> s = s.*s
>> cumsum(s)/sum(s)
```

Experiment 1: singular values and process complexity

Files **EEG_av.dat**, **EEG_pe.dat**, and **EEG_ap.dat** contain four EEG signals (columns) from a patient with Parkinson's disease implanted with an electrical stimulation device (sampling frequency 512 Hz). **EEG_av** has been recorded prior to stimulation, **EEG_pe** during stimulation (à 100 Hz) and **EEG_ap** after stimulation.
After removing the means and normalizing the variances, compute in all three situations the singular value decomposition of the data matrix (use the ″economy size″ option), and divide the singular values by the largest one. Deduce from these values:
- that the signals are much more correlated during stimulation
- that ″after″ is between ″prior″ and ″during″ from the viewpoit of signal correlation, which suggests a remanence effect in the stimulation.

Experiment 2: verification of feature uncorrelatedness

File **P09S03_dist.dat** contains 6 columns corresponding to 6 features extracted from successive 200-samples windows in a recording of signals from accelerometers placed on the wrists (3 accelerometers per wrist).
The first 3 features correspond to an estimate of the joint power in corresponding accelerometer pairs right/left wrists in the frequency band 2-5 Hz, and the other three features to the same pairs, frequency band 17-19 Hz.
Observe the evolution of the effective rank (cf. remarks) for the raw feature matrix, then on the feature matrix with means removed, then after additional variance normalization. Conclude on the utility of these operations.

Experiment 3: effective rank of ECG signals and application of the eigenfilter

File **AA_Valve** contains 500 samples from the 12 ECG electrodes (sampling frequency 50 Hz) during an episode of atrial fibrillation, after ventricular activity cancellation. The extension ″Valve″ comes from the fact the clinicians have determined this fibrillation is due to a dysfunctioning of the cardiac valves.

1. Extract the singular values on the first sic columns only (electrodes I, II, III, VR, VL, VF). What is the conclusion? Do the same on the last six columns (electrodes V1 – V6), and estimate the effective rank (cf. remarks). What is the conclusion?
2. Apply the eigenfilter (length 20) to the signals from electrodes V3 and V4 (file columns 9 and 10). You can observe that the filters extract the meaningful component of fibrillation (a little more than 5 Hz).
3. Stack the plots of the two original signals, which allows you to observe that ventricular activity cancellation is imperfect. Stack also the plots of the two filtered signals, which allows you to check that in these two electrodes the fibrillation activity is much correlated (oscillation amplitude).