6/16/2016

Project Info:
Create a real-time signal processing program taking in EEG/EMG data in 5 second windows and classify the windows into sleep states based on certain EEG/EMG features. Slice data->transform to spectral domain->classify through machine learning->output behavioral states
Priorities in order:

1. Get a script to process and output a file that has the time series classified. Control laser with TTL pulses.
2. Get visualizations of the data and the states
3. Have a nice interface to streamline the process.

Today's Goal: Find literature about features for classifying EEG/EMG data.

Control of REM sleep by ventral medulla GABAergic neurons

They wrote a "custom-written" Matlab program to do automatic classification of their behavior states (REM/NREM). First, they calculated the power spectrum of the EEG/EMG data using a 5 second window shifted by 2.5 second intervals. They took a sum of the EEG power for frequencies 1-4 Hz and 6-12 Hz, which gave a delta and theta power value. They took the ratio (delta/theta). They also computed total EMG power for 20-300 Hz frequencies. Following was their classification threshold algorithm:

if delta power<avg_delta power && emg power<avg_emg power+1SD—>NREM
if delta power<avg_delta power && |theta/delta|>1SD && emg power<avg_emg power+1SD—>REM
else—>Wake
so wake was characterized by high EMG (active) or low delta without elevated EMG and delta/theta ratio (quiet)

PyEEG Library

The following are features PyEEG can extract.

Feature name	Function name	Return type
Power Spectral Intensity (PSI) and Relative Intensity Ratio (RIR)	bin_power()	Two 1-D vectors
Petrosian Fractal Dimension (PFD)	pdf()	A scalar
Higuchi Fractal Dimension (HFD)	hfd()	A scalar
Hjorth mobility and complexity	hjorth()	Two scalars
Spectral Entropy (Shannon's entropy of RIRs)	spectral_entropy()	A scalar
SVD Entropy	svd_entropy()	A scalar
Fisher Information	fisher_info()	A scalar
Approximate Entropy (A p E n)	ap_entropy()	A scalar
Detrended Fluctuation Analysis (DFA)	dfa()	A scalar
Hurst Exponent (Hurst)	hurst()	A scalar

A Tutorial on EEG Signal Processing Techniques for Mental State Recognition in Brain-Computer Interfaces.

LDA is an unsupervised algorithm that is widely used in signal processing. There are three main sources of information that can be used for feature extraction in EEG signals:

Spatial Information- Where the signals are coming from.
Spectral Information- How power varies across frequencies
Temporal Information- How the signal varies over time