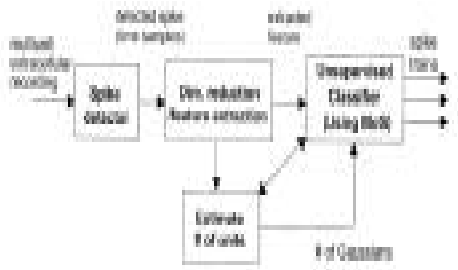
Unsupervised Classification of Neural Signal Recordings

Anna Wagner
ELE482
University of Rhode Island
Kingston RI 02881

There has been great interest in neural recordings. Extracellular neural recordings are very important to further our understanding of the workings of the nervous system. Many current studies are being performed to take these recordings and classify them. In this particular article, the goal was not just to classify the signals, but to do so unsupervised and with no forehand knowledge of the signals. It also was created to show high performance under low SNR.

To do so, a mixture of AP detectors, a dimensionality reduction scheme, and a proper unsupervised classification method were applied. To work even in low SNR situations, a projection pursuit method based on negentropy maximization (CPP/NEM) was implemented. A linear transform was used because it preserves the underlying shape of distribution in high dimension, which allows pdf modeling of the extracted feature vectors possible. The clustering algorithm was based on a modeling of pdf by a mixture of Gaussians (MoG). To be able to prove that this method works, signals that have already been analyzed must be used. The signals were from the abdominal ganglion of Aplysia and the somatosensory cortex of a Sprague-Dawley rat. The signal was then bandpass filtered. Template waveforms and an AR model of background noise was used to generate waveforms of arbitrary SNR with characteristics resembling real experimental recordings.



As you can see in this diagram, the signal was passed through a spike detector, then its dimension was reduced and features extracted. To use the MoG, you must estimate the # of units. To do this, we use PP/NEM. Even if the number of units estimated exceeds the actual number of units, the program will correct for that and the actual number of spikes will be the output.

Then the modes are found, to find the locations and features of each spike. This method was compared to 3 other methods: another linear method, and two non-linear methods. The MoG method proved far superior to the other methods. It had the most true hits and least false hits. The other linear method was second best, and the non-linear methods were of no use.

K. Kim, S. Kim, *Method for Unsupervised Classification of Multiunit Neural Signal Recording Under Low Signal-to-Noise Ratio.* IEEE Transactions on Biomedical Engineering, Vol.50, No. 4, April 2003.