Hindawi Publishing Corporation
EURASIP Journal on Advances in Signal Processing
Volume 2009, Article ID 105086, 1 page
doi:10.1155/2009/105086

Editorial

Statistical Signal Processing in Neuroscience

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Received 31 December 2009; Accepted 31 December 2009

When the three of us decided to coedit a special issue on Statistical Signal Processing in Neuroscience, we implicitly knew that the submitted papers would span a wide field, the field measured in coordinate system with disparate axes: engineering-oriented or scientific; analysis of single neuron, populations or aggregate activity recordings; and known signal processing techniques or novel ones "invented" for the neuroscience application. We were not disappointed. The six papers chosen for this special issue represent the best of the submitted papers.

The papers span a wide variety of very challenging problems. Some focus on basic estimation theory for reconstructing sensory stimuli from spike trains, while others focus on the prediction of seizure activity from EEG signals in clinical applications. Two papers are inspired by recent striking advances in Brain Machine Interface technology that is aimed at improving our basic understanding of brain function, and possibly restoring, replacing, or augmenting it when it is damaged.

The paper by Lazar and Pnevmatikakis, "Reconstruction of sensory stimuli encoded with integrate-and-fire neurons with random thresholds", employs a fresh idea—time encoding machines—inspired by neural systems that holds promise for new signal processing applications. This paper explores how to optimally decode population responses created within the time-machine encoding framework.

Darmanjian and Principe's paper, "Spatial-temporal clustering of neural data using linked-mixtures of hidden Markov models", looks at HMM decoding of new populations using unsupervised hierarchical clustering for brain-machine interface (BMI) applications, focusing on motor control.

Next, the paper by Filho et al., "Magnitude squared of coherence to detect imaginary movement", analyzes ERP data using cross-spectral analysis on a large scale, again for a motor BMI application.

In contrast, Krusienski's paper "A Method for visualizing independent spatio-temporal patterns of brain activity" uses a new spatio-temporal analysis of EEG data to tease out the basic independent patterns from which the measurements were constructed.

Continuing along the axis of using modern algorithms, Liu, Pang and Wang explore in their paper "Epileptic seizure prediction by a system of particle filter associated with a neural network" using statistical bayesian filters to analyze EEG data.

Finally, Hu et al. propose using a realistic nonlinear model rather than a linearized version to analyze multivoxel behavior in fMRI images in their paper "Nonlinear analysis of the BOLD signal."

We hope you enjoy these articles as much as we did reviewing them.

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