Introduction

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INTRODUCTION

"Neuroengineering: from Neurosciences to Computations" presents seminal contributions at the intersection of neurosciences and artificial neural networks and computation. Papers range from novel proposals on neural models, structures and analysis, to advances in computational applications through mathematical modeling.

At the bio-inspired neural modeling level, a realistic spiking computational model of the cerebellum is used in the first paper to analyze the link between alterations at the network level and cerebellar dysfunction; the outcome was compared to reference results obtained in human or animal experiments. Generalization capabilities of the cerebellar spiking model are then extended to pathological cases and used to predict how changes at the neuronal level are distributed across the network, allowing the inferring of cerebellar circuit alterations occurring in cerebellar pathologies. In a second paper, a Structured Pyramidal Neural Network is presented, which is a variation of the Pyramidal Neural Network based on the human visual system and deep learning theory. The new network has self-adaptive variable receptive fields and a smaller number of parameters.

As applied research, monitoring brain activity through electroencephalography using a brain-computer interface makes one step towards understanding the neural correlates of perception of harmonic rhythm. In the third paper, and in the following contribution, rhythmic binaural sound is applied to Parkinson's disease patients to investigate its influence on several symptoms of this disease and on electrophysiology (electrocardiography and electroencephalography). It was found that sound, particularly binaural-rhythmic sound, may be a co-assistant tool in the treatment of the disease. Application areas include computer vision which is addressed in the fourth paper on background image modeling, when the background is dynamic and the input distribution might not be stationary. In this work, an unsupervised learning neural network is proposed which is able to cope with progressive changes in the input distribution. It is based on a dual learning mechanism which manages the changes of the input distribution separately from cluster detection. The performance of the method is tested against several state-of-the-art foreground detectors both quantitatively and qualitatively, with favorable results.

Finally, an original mirror neuron model based on the spike-timing dependent (STDP) synaptic plasticity between two morpho-electrical models of neocortical pyramidal neurons is presented. Both neurons fired spontaneously with a basal firing rate that follows a Poisson distribution, and the STDP between them was modeled by the triplet algorithm. The simulation results demonstrated that STDP is sufficient for the rise of mirror neuron function between pairs of neocortical neurons. This is a proof of the concept that pairs of neocortical neurons associating sensory inputs to motor outputs could operate like mirror neurons. In addition, the mirror neuron model is used to investigate whether channelopathies associated with autism spectrum disorder could impair the modeled mirror function. Results showed that impaired hyperpolarization-activated cationic currents affected the mirror function between pairs of neocortical neurons coupled by STDP.

To select these seminal papers that bridge neurosciences and computation has been a challenging task for the editors and reviewers who had to keep their minds open to new proposals at a time when high scientific and formal evidences of performance are required. With this purpose, each manuscript submitted for possible publication in the special issue underwent at least two cycles of reviews and re-reviews. The six papers included in this special issue each received 5 to 9 reviews and went through three cycles of reviews according to the journal's rigorous standard of publication in order to produce a special issue meeting the expectations of IJNS readers.

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