Wireless Brainwave Classification for Alzheimer's Patients via Efficient Neural Network Computation

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Alzheimer’s disease diminishes one's ability to express thoughts and basic needs, causing communication issues between patients and their caretakers. To bridge this communication gap, a thought-recognition software is needed to classify patient brainwaves recorded by a wearable wireless headset. The nature of wireless brainwave data is its low quantity and limited resolution due to patients' short attention span and the restricted number of sensors in the wireless headset. Low quantity of data is a major difficulty for feature extraction, which is essential for classification. Because of such unique characteristics, standard neural networks are unable to achieve high accuracy in classifying the data. My project aims to construct a dimension-reduced neural network model, capable of extracting intrinsic features in low dimension, trained by an innovative Alternating Minimization (AM) algorithm to classify wireless brainwave data at high accuracy. My AM algorithm minimizes the objective function more effectively than the gradient descent method (used in standard neural networks). Based on my discovery of piecewise convexity of the objective function, a bisection procedure is devised to compute a global minimum in each variable with others being fixed. Consequently, the iterative AM algorithm descends and converges rapidly, reaching high accuracy on classifying data with limited resolution. In various tests conducted, my prediction results consistently achieved 90% accuracy in classifying 4 daily thoughts of an Alzheimer’s patient. My dimension-reduced neural network model makes it possible to classify data from a wearable wireless headset in real-time.

Awards Won:

Fourth Award of $500

Oracle Academy: Award of $5,000 for outstanding project in the systems software category.