Title: Quantification of neural information and a subsequent coding scheme

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Project Summary: All of an organism's information about the sensory world comes from real-time observation of the activity of its own neurons. In coming sensory information is represented in sequences of essentially identical action potentials, or spikes. To understand real-time signal processing in biological systems, one must first understand this representation (Bialek et al., 1991). In this work we intend to undertake a numerical representation of multiple spike trains from a network of simultaneously active neurons during a cognitive task or an epileptic seizure. Unfortunately the classical information theory is not very well suited for modeling the neural information that is encoded in the neural signals (Johnson, 2010). In this work we are planning to introduce a new measure to quantify information in the time domain electrophysiological signals. We would be studying how information is exchanged between different brain regions from planning to execution of different tasks or during generation and propagation of epileptic seizures in the temporal lobe (Wendling et al. 2003). Information content in a channel has to be quantified. This quantification itself is a time series or signal. A phase synchronization between two such signals may give a measure of information flow between them. For directionality Granger causality may be used. Our preferred mode of neural data will be ECoG. We will also extend the analysis to EEG. Some of these studies have already been carried out by entropy measure (Bialek et al., 1991). Since entropy measure and our measure do not have positive correlation this study is worth undertaking. Based on this quantification of information in the electrical signals an algebraic coding scheme will be developed, which we expect will help correcting errors during task execution in the brain computer interface (BCI) operations.