Control of oscillations in exact firing rate models with applications to neural communication

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Abstract:

The brain exhibits oscillations at different scales, ranging from individual neurons to populations, and they have been associated to several cognitive functions, including perception and attention. It has been suggested that oscillations play a role in communication within the brain. The Communication Through Coherence theory (Fries, 2005, 2015), proposes that effective communication between oscillating neural groups requires synchronization at the appropriate phase of oscillation. In this presentation, we will investigate this phenomenon in populations of excitatory and inhibitory neurons using an exact mean-field model (Montbrio et al, 2015). Our aim is to synchronize the oscillations of two populations using control techniques, where the control is the action of a higher cortical area (mimicking a top-down mechanism). Thus, we consider a network composed of two pre-synaptic oscillatory populations that influence a post-synaptic population. We aim to synchronize the post-synaptic population with just one of the pre-synaptic populations so that effective communication can be established. To achieve this, we will apply a control to the receiving population, which will regulate the frequency of oscillations and set the oscillatory groups in the appropriate phase for communication. We use the phase-amplitude reduction of a limit cycle along with optimal control techniques.