Title: Modeling and identification of brain network dynamics underlying mood disorders

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Theme:
Neuromodulation

Keywords: neural dynamics, neuromodulation, mood disorders, brain-machine interfaces

ABSTRACT

Modeling of brain network dynamics and identification of the effect of electrical stimulation on such dynamics are essential for devising closed-loop therapies for depression and other neuropsychiatric disorders. We build dynamical state-space models of brain network activity that reflect the underlying changes in patient's mood. We also design a novel stimulation pattern--a pulse train modulated by binary noise (BN) parameters--that satisfies both optimality constraints for system identification and clinical safety constraints. Using field potentials recorded from epilepsy patients with co-occurring depression, whose mood was periodically measured using an immediate mood scalar, we identified a reduced-order neural state-space model. We found that 1) the identified models accurately predicted the neural network dynamics and 2) the underlying states were predictive of changes in mood. We also showed that BN-stimulation enabled accurate input-output identification. These results have significant implications for the development of model-based feedback controllers for treatment of neuropsychiatric disorders.