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Synchronization in a network of controlled oscillatory cellular automata

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In fields from biology to engineering, dynamic processes occur in networks. A prototypical example is a network of interacting myocytes, cells that make up the tissue of the heart and are crucial in performing the heart's main function, which is pumping blood. One would like to understand how the structural properties of the network together with the dynamic models of interacting entities shape the desired goals. In particular, what happens in the Kuramoto model of interacting oscillators that exhibit spontaneous collective synchronization in steady state, when these oscillators are forced to reset to their initial state by an external controller.

The lecture will be devoted to discussing the proposal of vagal nerve control over the rhythm of heart contractions, which is based on the model of oscillatory timed cellular automata as the framework of heart tissue. It turns out that the obtained model agrees well with the observational data. Especially it allows to identify and quantify some of the damage to the heart tissue that manifests as atrial arrhythmia which, if left untreated, can lead to dysregulation of the entire cardiac conduction system.