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The Bifurcation Study of 1:2 Resonance in a Delayed System of Two Coupled Neurons

In this paper, we consider a delayed system of differential equations modeling two neurons: one is excitatory, the other is inhibitory. We study the stability and bifurcations of the trivial equilibrium. Using center manifold theory for delay differential equations, we develop the universal unfolding of the system when the trivial equilibrium point has a double zero eigenvalue. In particular, we show a universal unfolding may be obtained by perturbing any two of the parameters in the system. Our study shows that the dynamics on the center manifold are characterized by a planar system whose vector field has the property of 1:2 resonance, also frequently referred as the Bogdanov–Takens bifurcation with Z2 symmetry. We show that the unfolding of the singularity exhibits Hopf bifurcation, pitchfork bifurcation, homoclinic bifurcation, and fold bifurcation of limit cycles. The symmetry gives rise to a "figure-eight" homoclinic orbit.

This is a joint work with Sue Ann Campbell (University of Waterloo), Gail S. K. Wolkowicz (McMaster University), and Huaiping Zhu (York University).