Effects of Discrete Time Delays and Parameters Variation on Dynamical Systems

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To understand the effects of discrete time delays and of parameter variations on certain biological system models, we carry out a bifurcation analysis of systems of delay differential equations. We present general result for one equation with one and two delays and study a specific example of one equation with one delay. We then establish the procedure for n equations with multiple delays and do a specific example for two equations with two delays. We investigate the stability of the steady states as both chosen bifurcation parameters, the discrete time delay τ and a local equation parameter μ, cross critical values. Our analysis shows that while changes in both parameters can destabilize the steady state, the discrete time delay can cause stability switches of the steady state for certain values of μ, while the effects of the local equation parameter on the steady state do not necessarily depend on the value of τ. While μ may cause the system to go through different type of bifurcations, the discrete time delay can only introduce a Hopf bifurcation for certain values of μ.