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Stability and Bifurcation in Predator Prey Systems with Cubic Interaction

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The predator prey problem involves a class of models that predict the interaction between populations of different species in the same environment where some of the species (predators) prey on the others. The prey exhibits linear growth given by a positive parameter. Predators consume preys with a nonlinear interaction involving another set of parameters that specify the competition between predators. The natural death rate of the predator is assumed to be linear and given by a negative parameter. One of the earliest implementations, the Lotka-Volterra model that serves as a starting point for more advanced population dynamics models used today. Stability problems in the Lotka-Volterra model and its generalizations constitute a field that has recently gained much attention. To understand the behavior of a nonlinear system one has to also analyze the existence and stability of equilibrium points which change as parameters vary. Changes in the number and stability of equilibrium points in these models leading to qualitative changes in the behavior of the system have been studied by bifurcation analysis in this work. Both numerical methods [1] and the semi-perturbative analytic approach provided by the normal form method are useful tools in this context.

Nutku [2] has proposed a generalization where an additional cubic rather than a quadratic interaction is involved. The numerical analysis of bifurcation and stability for this generalized system is studied with the help of the MatLab package MATCONT[3]. Then the normal form structure for a nontrivial equilibrium is achieved by linearizing the system and analyzing the existence of Hopf bifurcation using the method of Kuznetsov[4].

Results of a study involving the bifurcation properties shown by generalized Lotka-Volterra models[5] including the Nutku generalization with a cubic interaction term that is shown to introduce additional changes of the stability properties in a simple way will be presented.

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