

Qualitative and quantitative features of delay differential equations and applications to biology

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Motivation and Aims: Recently much attention has been given to mathematical modeling of real-life phenomena using differential equations with memory, such as delay differential equations (DDEs). This is due to the fact that introduction memory terms in a differential model significantly increases the complexity of the model. Such a class of DDEs is widely used for analysis and predictions in various areas of life sciences and modern topics in population dynamics, computer science, epidemiology, immunology, physiology, and neural networks. In this paper, we provide a wide range of delay differential models that have a richer mathematical framework (compared with ODEs) for the analysis of biosystems. Qualitative and quantitative features of DDEs are discussed. Some numerical simulations are also provided to show the effectiveness of the theoretical results.

Results and Conclusions:

1. DDEs of real-life phenomena have potentially more interesting dynamics than equations without memory;
2. The time-delay (memory) is incorporated into systems to describe resource regeneration times, maturation periods, reaction times, feeding times, gestation period, etc.;
3. Studying qualitative behaviour of DDEs is essential for ensuring safe applications or real problems;
4. The presence of memory in the model enriches the dynamics of the model: It can stabilize or dis-stabilize the system
5. Mono-implicit continuous RK schemes are stable and suitable for stiff and non-stiff DDEs
6. Sensitivity functions clearly demonstrate the measure of the importance of the input parameters.
7. Sensitivity functions enable one to assess the relevant time intervals for the identification of specific parameters.

References

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