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Finding the periodic solutions of delayed differential equations via solving optimization problem

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Abstract:

Delay differential equations (DDEs) have got a wide range of applications in many fields of engineering and science. However, many DDE models cannot be treated by existing analytical methods. The investigation of such models requires numerical methods to analyze the stability and bifurcation behavior. The shooting method is a popular one to compute the periodic solutions of a DDE system. However, the computational cost of each iteration step is extremely high when a fine discretization is used on the delay interval.

By establishing the Poincaré map and considering the phase drift conditions, this paper transforms the computation of the periodic solution into an optimization problem with constraints. Then we propose a numerical technique to get approximately the initial function by function fitting. Numerical experiments verify the effectiveness of the proposed algorithm. The results show that the proposed method does not need a large number of unknown variables, and improve the computational efficiency greatly compared to that using the function interpolation method.

Keywords: Time delay; optimization; periodic solution; shooting method; initial functions.