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Parameter Estimation for ODEs using a Cross-Entropy Approach

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Abstract

Parameter Estimation for ODEs and DDEs is an important topic in numerical analysis. In this talk, we present a novel approach to address this inverse problem. Cross-entropy algorithms are general algorithm which can be applied to solve global optimization problems. The main steps of cross-entropy methods are first to generate a set of trial samples from a certain distribution, then to update the distribution based on these generated sample trials. To overcome the prohibitive computation of standard cross-entropy algorithms, we develop a modification combining local search techniques. The modified cross-entropy algorithm can improve the convergence rate and the quality of the converged solution. Two different coding schemes (continuous coding and discrete coding) are also introduced. Continuous coding uses a truncated multivariate Gaussian to generate trial samples, while discrete coding reduces the search space to a finite (but dense) subset of the feasible parameter values and uses a Bernoulli distribution to generate the trial samples (which are fixed point approximation of the actual parameters) . Extensive numerical experiments are conducted to illustrate the power and advantages of the proposed methods. Compared to other existing state-of-the-art approaches on some benchmark problems for parameter estimation, our methods have three main advantages: 1) They are robust to noise in the data to be fitted; 2) They are not sensitive to the number of observation points (in contrast to most existing approaches) ; 3) The modified versions exhibit faster convergence without sacrificing accuracy.