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.