Uncertainty Quantification on Linear Dynamical System

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Abstract

Uncertainty quantification (UQ) is a new and hot branch of computer experiment that provides a calibration on parameter estimates in a computer model when small perturbations exist. In this paper, we first study the continuous-time linear dynamical system described by discretizing the partial differential equations. This type of system has many important applications such as circuits, signal processing, spectroscopy, control theory and many others. In order to understand the random errors, we add some perturbations to the parameters in the system that involves some uncertainties. When we choose the optimal control to minimize a cost function, one way is to solve the continuous-time Riccati differential equation and the solutions represent the approximations of the corresponding random process. Moreover, we also discuss the continuous-time algebraic Riccati equation when we consider the infinite time. We should provide the sufficient conditions for the existences of the stabilized solutions of the stochastic continuous-time linear dynamical system. Then the study is extended to the discrete-time linear dynamical system. Some numerical simulations of the stochastic linear dynamical systems are presented.

Keywords: Uncertainty quantification, Riccati differential equation, Riccati difference equation, stochastic model, continuous- and discrete-time algebraic Riccati equations.