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System Identification through Online Sparse Gaussian Process Regression with Input Noise

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Abstract

There has been a growing interest in using non-parametric regression methods like Gaussian Process (GP) regression for system identification. GP regression does traditionally have three important downsides: (1) it is computationally intensive, (2) it cannot efficiently implement newly obtained measurements online, and (3) it cannot deal with stochastic (noisy) input points. In this paper we present an algorithm tackling all these three issues simultaneously. The resulting Sparse Online Noisy Input GP (SONIG) regression algorithm can incorporate new noisy measurements in constant runtime. A comparison has shown that it is more accurate than similar existing regression algorithms. When applied to nonlinear black-box system modeling, its performance is competitive with existing nonlinear ARX models.

Keywords: Nonlinear system identification, Gaussian processes, regression, machine learning, sparse methods.

1. Introduction

The Gaussian Process (GP) (Rasmussen and Williams, 2006) has established itself as a standard model for nonlinear functions. It offers a representation that is non-parametric and probabilistic. The *non-parametric* nature of the GP means that it does not rely on any particular parametric functional form to be postulated. The fact that the GP is a *probabilistic* model means that it is able to take uncertainty into account in every aspect of the model.

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