Highly efficient maximum-likelihood identification methods for bilinear systems with colored noises

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Research Article

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Abstract

As a special class of nonlinear systems, bilinear systems can naturally describe many industrial production process. This paper mainly discussed the highly efficient iterative identification methods for bilinear systems with autoregressive moving average noise. Firstly, the input-output representation of the bilinear systems is derived through eliminating the unknown state variables in the model. Then based on the maximum-likelihood principle and the negative gradient search principle, a maximum-likelihood gradient-based iterative (ML-GI) algorithm is proposed to identify the parameters of the bilinear systems with colored noises. For further improving the computational efficiency, the original identification model is divided into three sub-identification models with smaller dimensions and fewer parameters, and a hierarchical maximum-likelihood gradient-based iterative (H-ML-GI) algorithm is derived by using the hierarchical identification principle. A gradient-based iterative (GI) algorithm is given for comparison. Finally, the algorithms are verified by a simulation example. The simulation results show that the proposed algorithms are effective for identifying bilinear systems with colored noises and the H-ML-GI algorithm has a higher computational efficiency and a faster convergence rate than the ML-GI algorithm and the GI algorithm.

Full Text

Due to technical limitations, full-text HTML conversion of this manuscript could not be completed. However, the manuscript can be downloaded and accessed as a PDF.

Figures

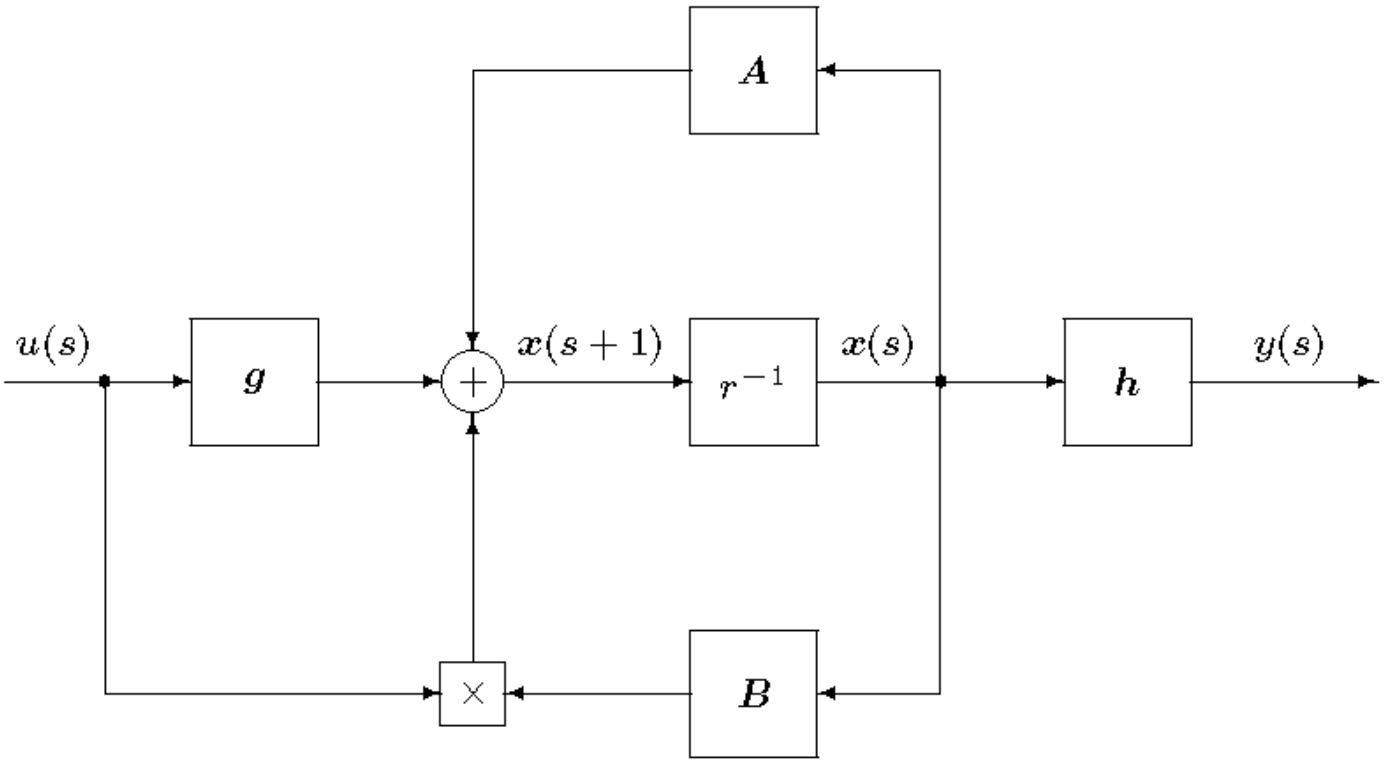

Figure 1

The bilinear state space system

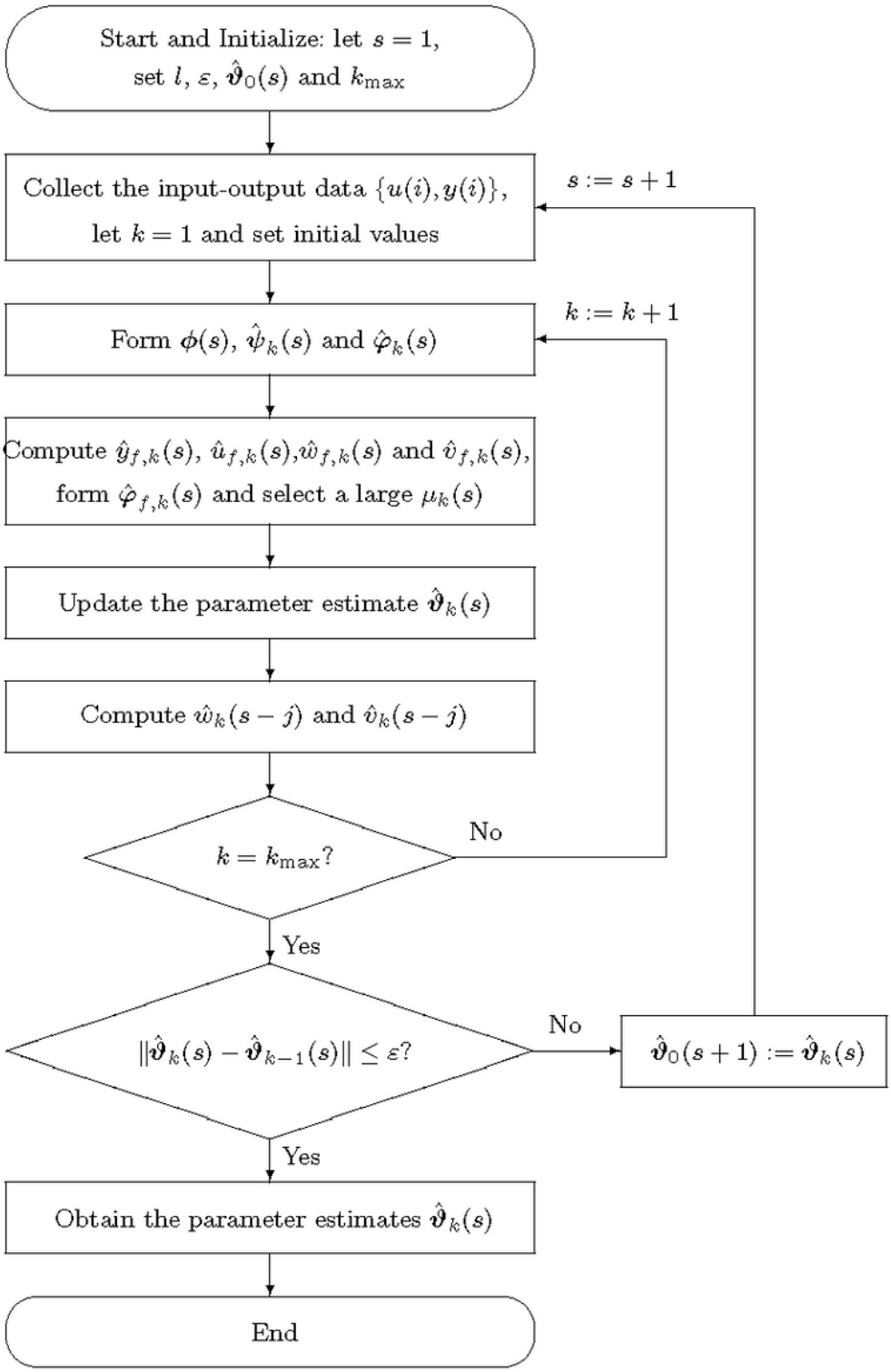

Figure 2

The flowchart of the ML-GI algorithm

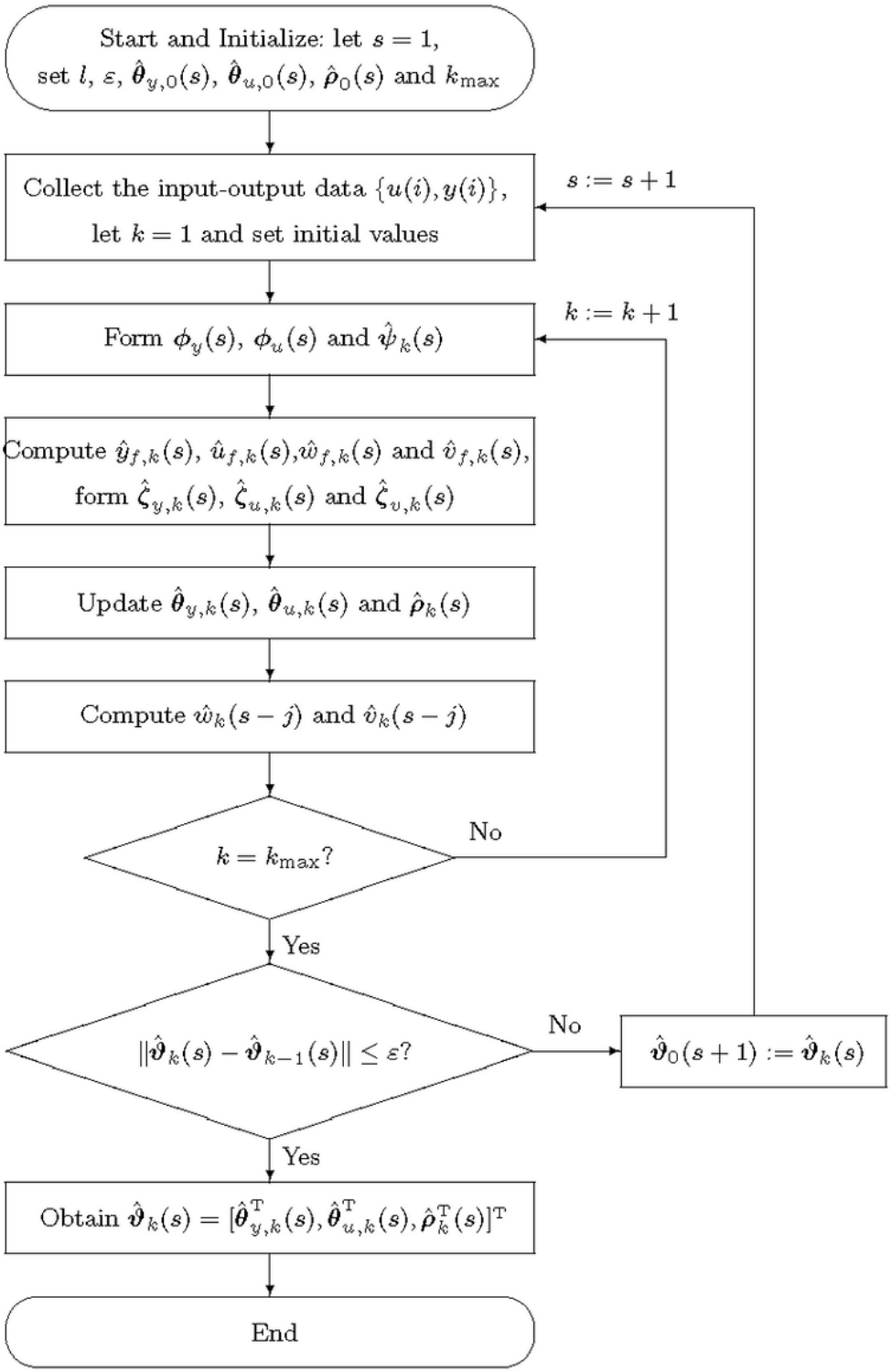

Figure 3

The flowchart of the H-ML-GI algorithm

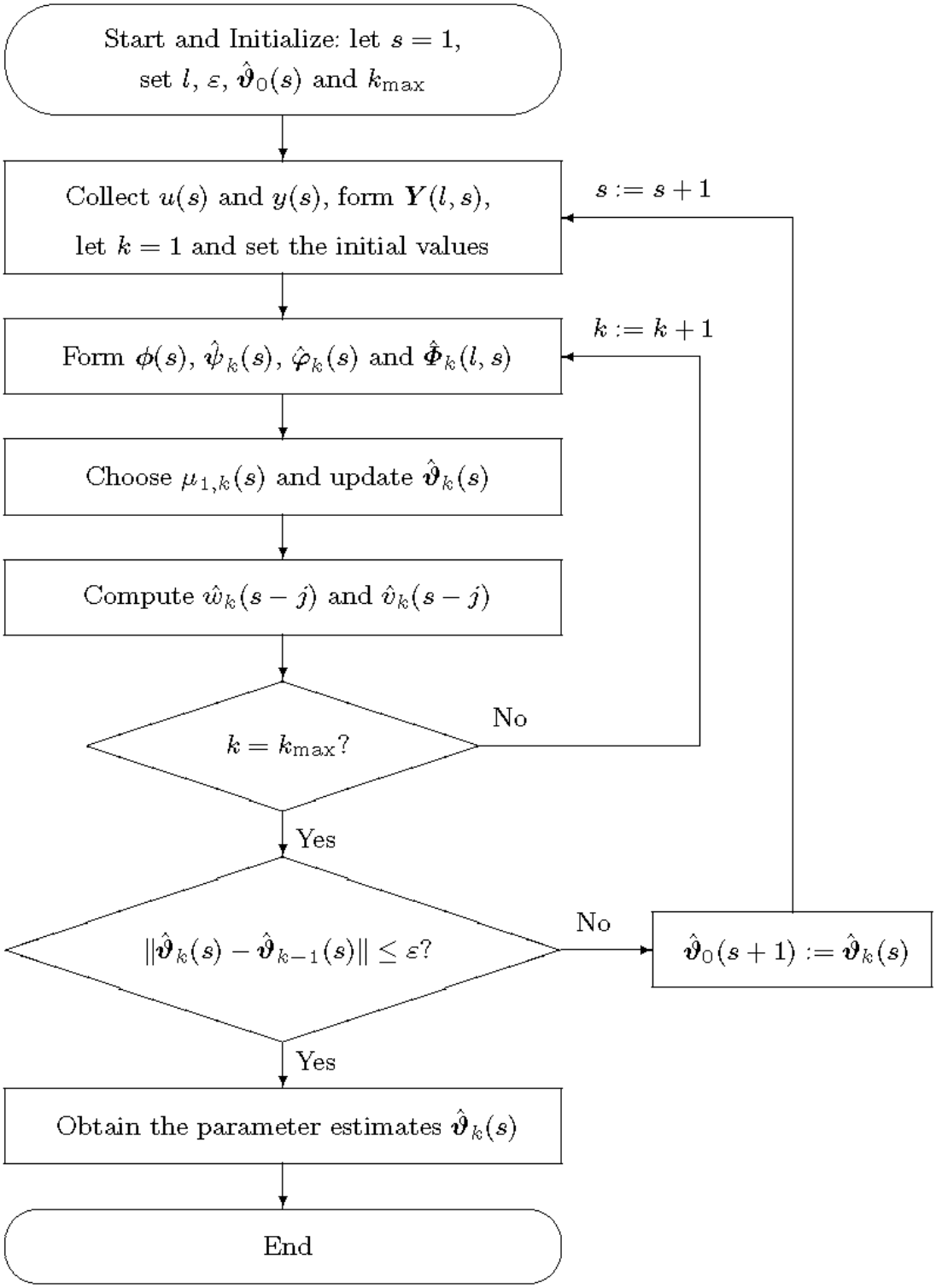

Figure 4

The flowchart of the GI algorithm

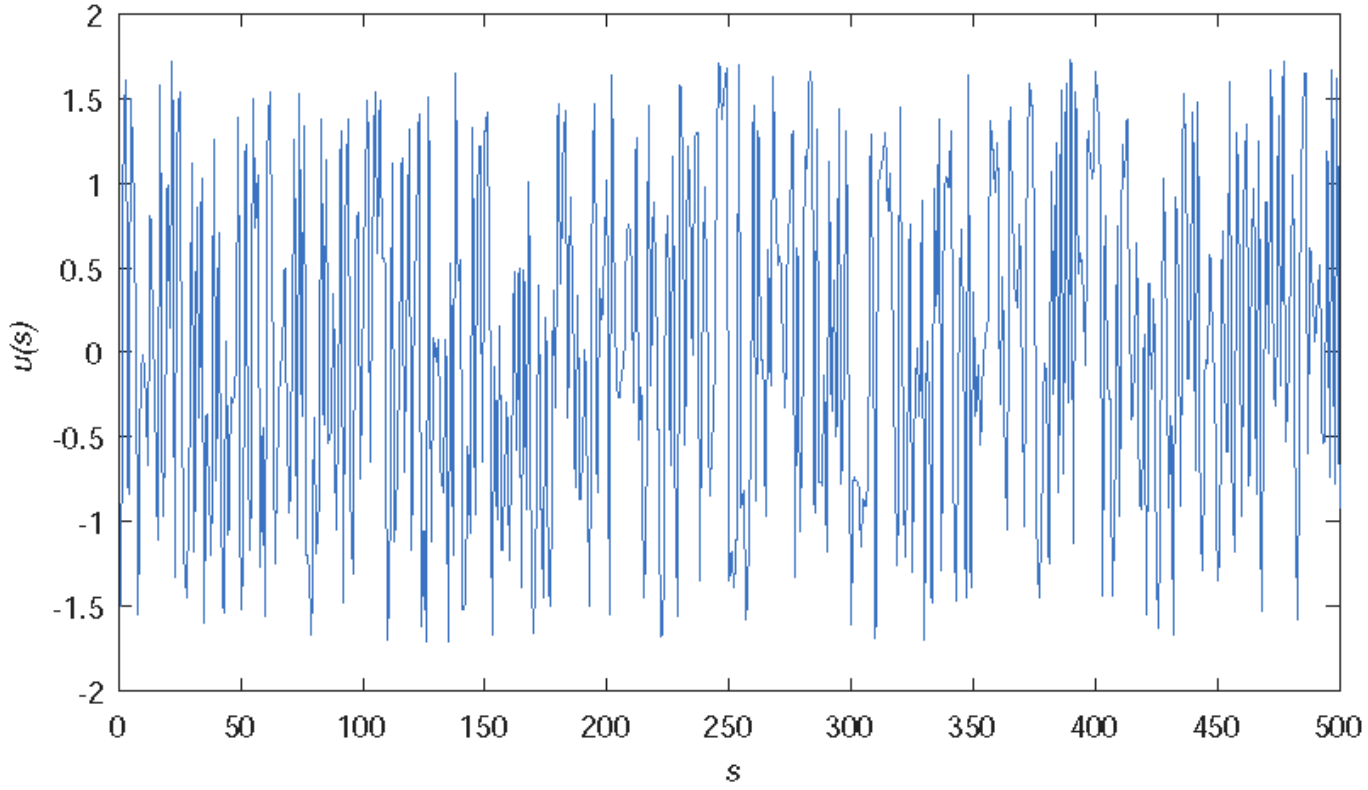

Figure 5

The input u(s) of the system

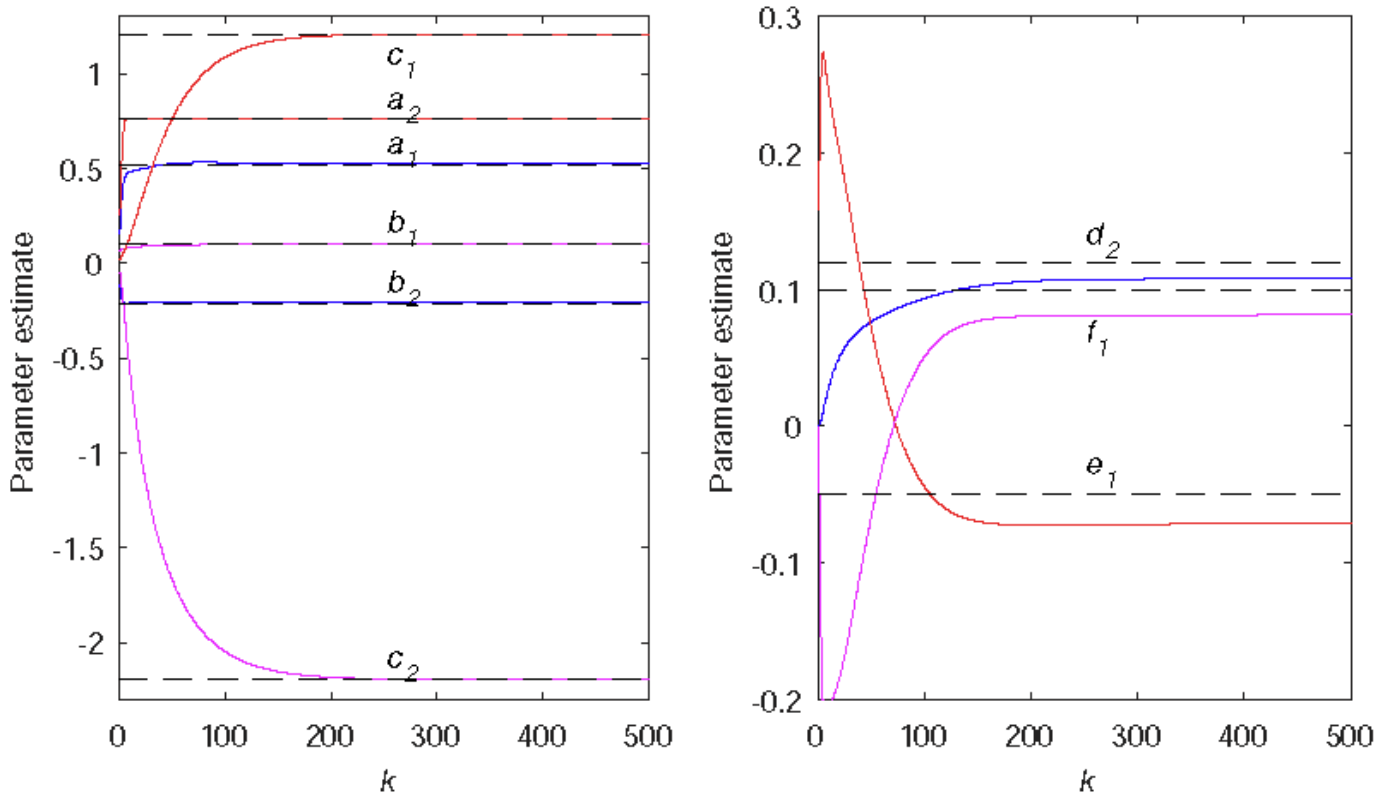

Figure 6

The ML-GI estimates versus k with σ2 = 1:002

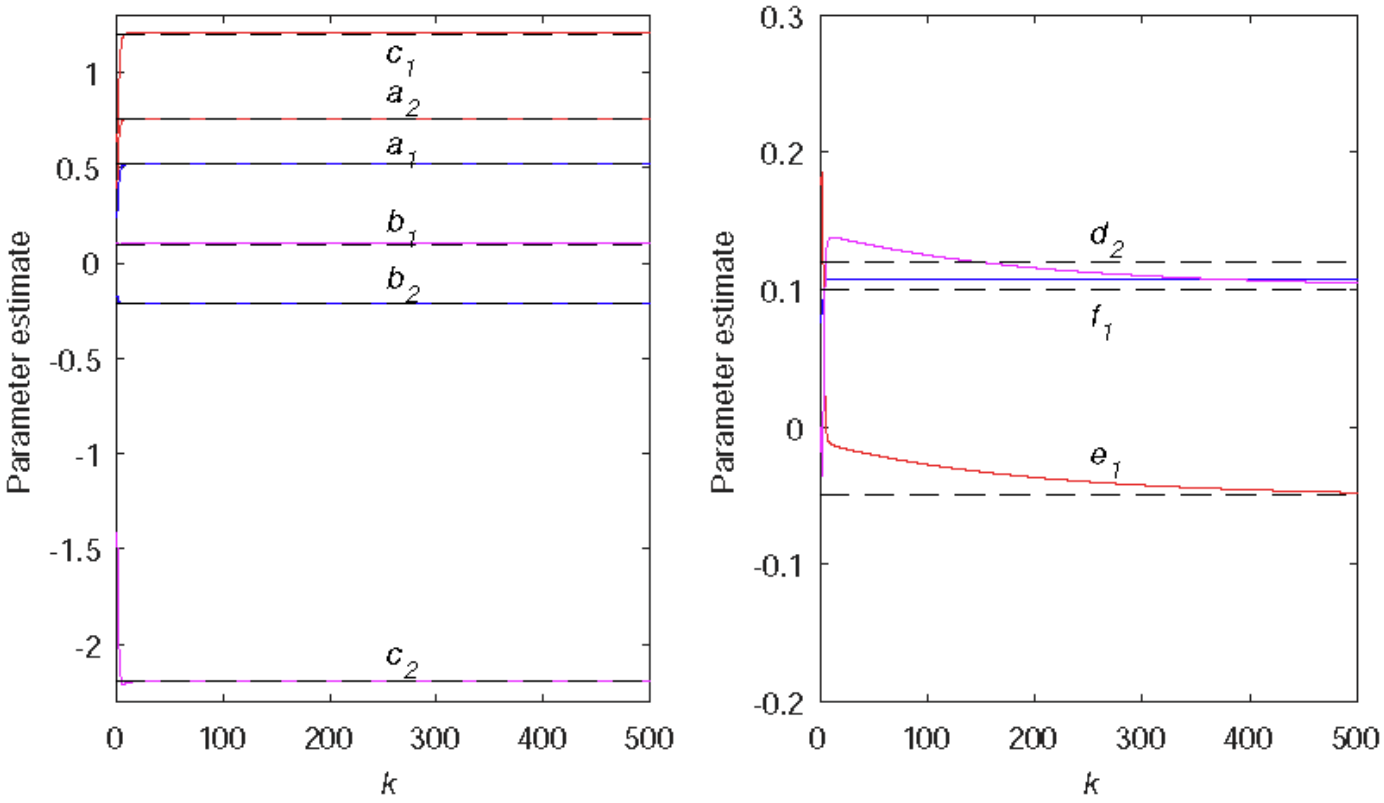

Figure 7

The H-ML-GI estimates versus k with σ2 = 1:002

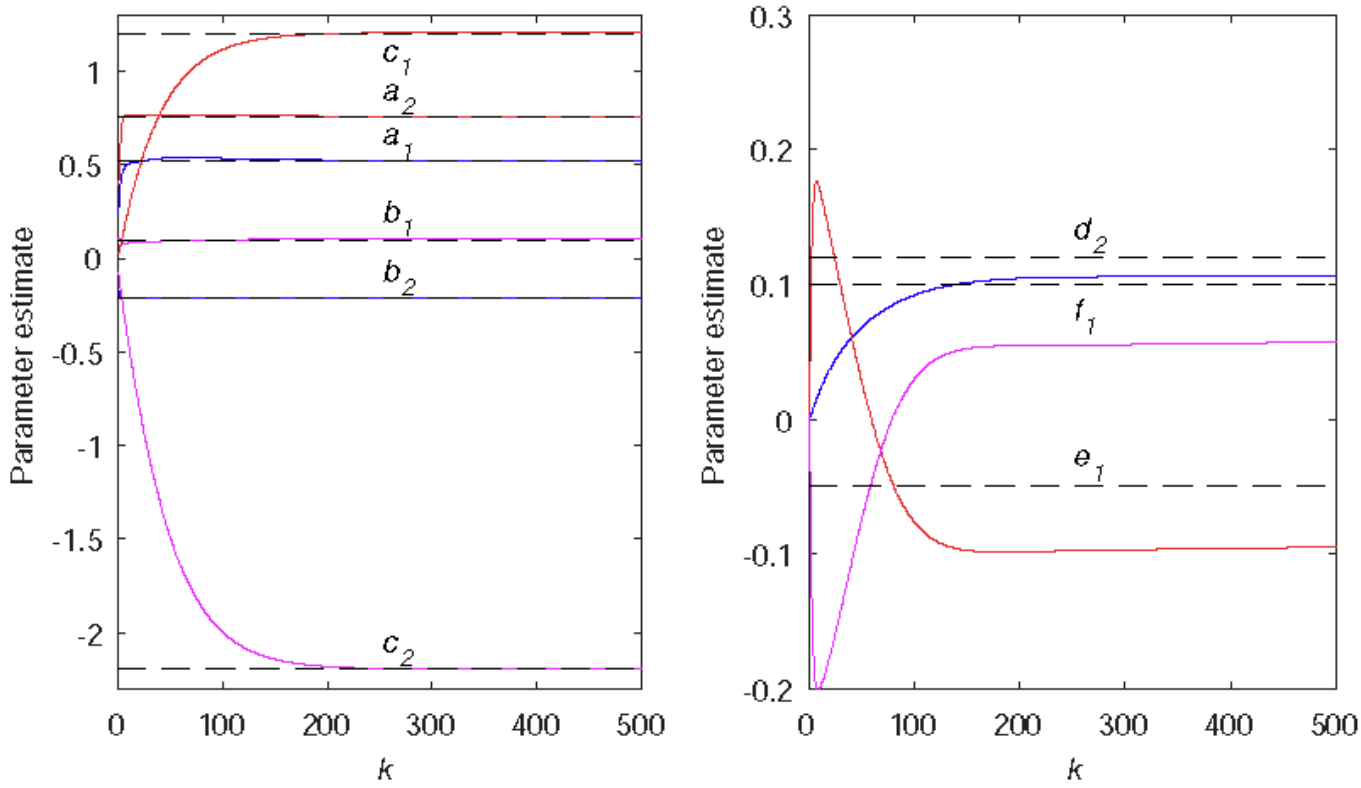

Figure 8

The GI estimates versus k with σ2 = 1:002

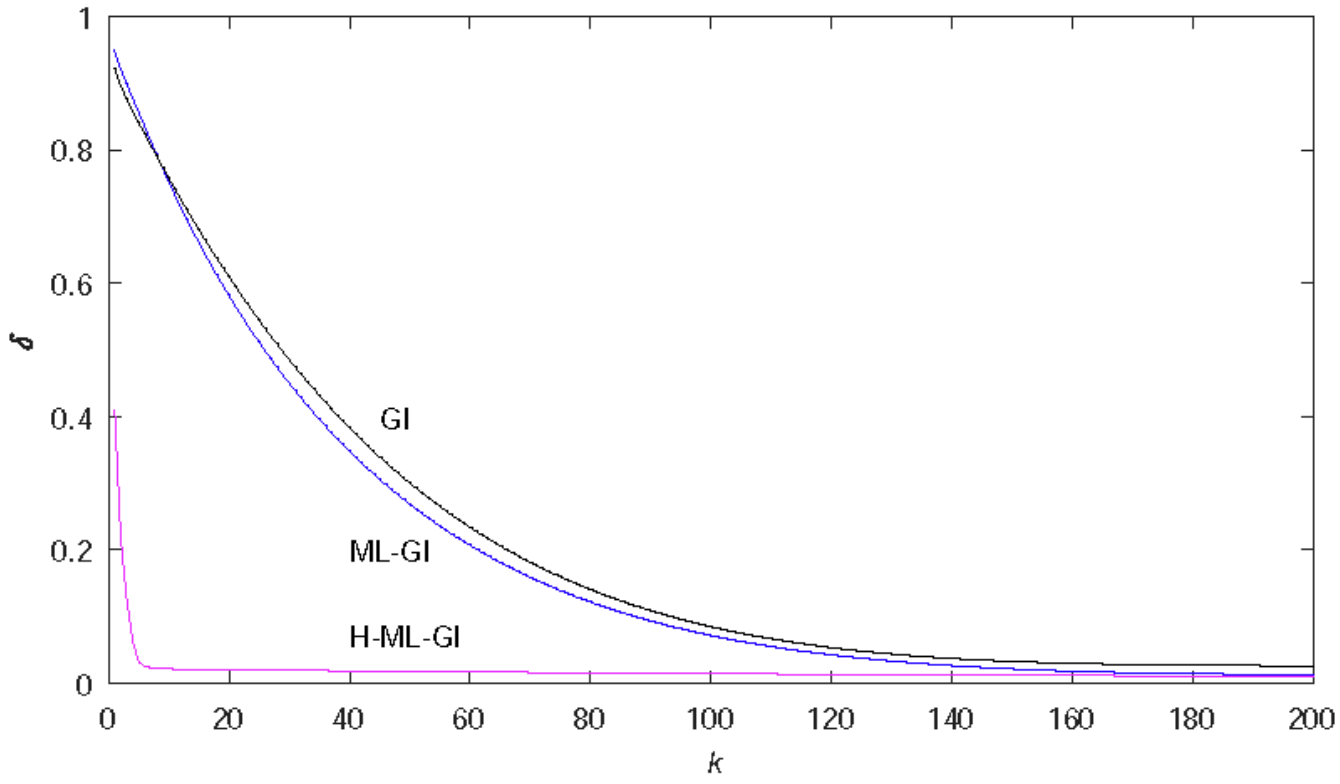

Figure 9

The estimation errors δ versus k with different algorithms (σ2 = 1:002)

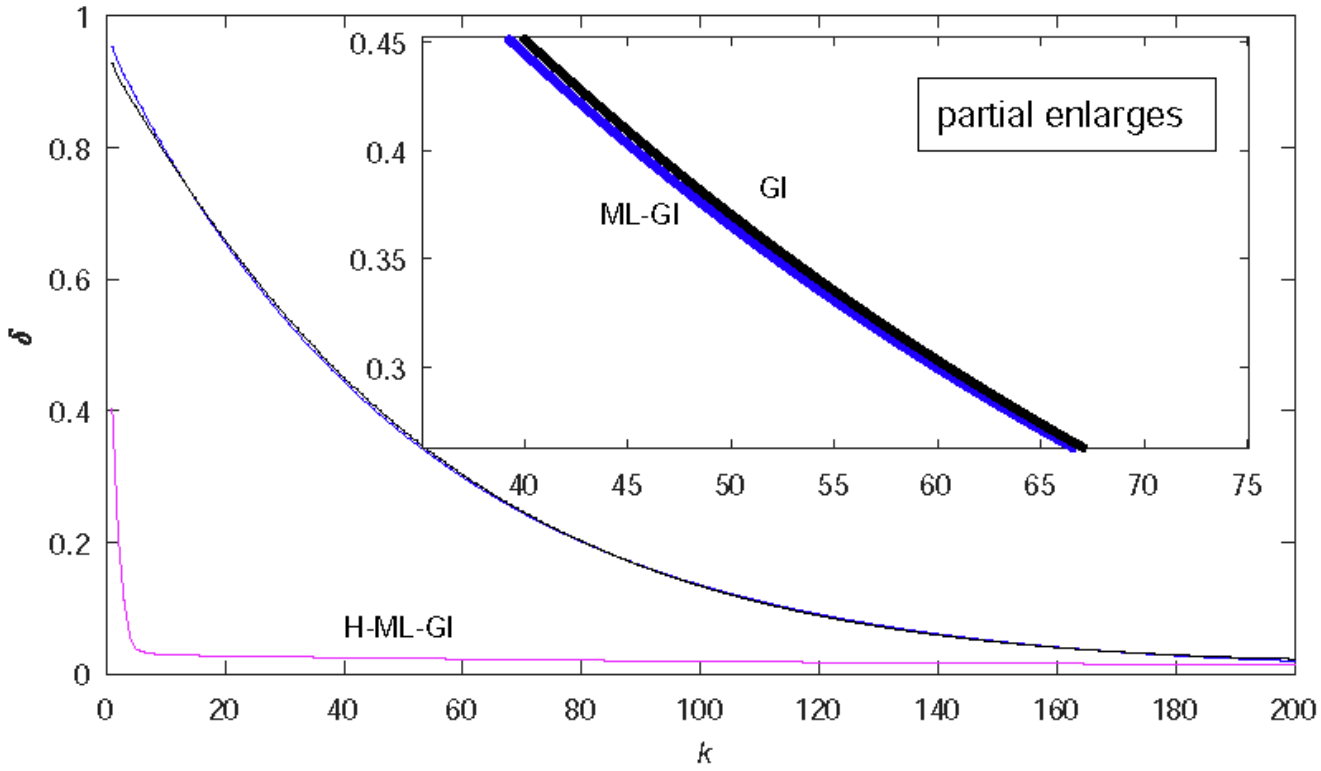

Figure 10

The estimation errors δ versus k with different algorithms (σ2 = 2:002)

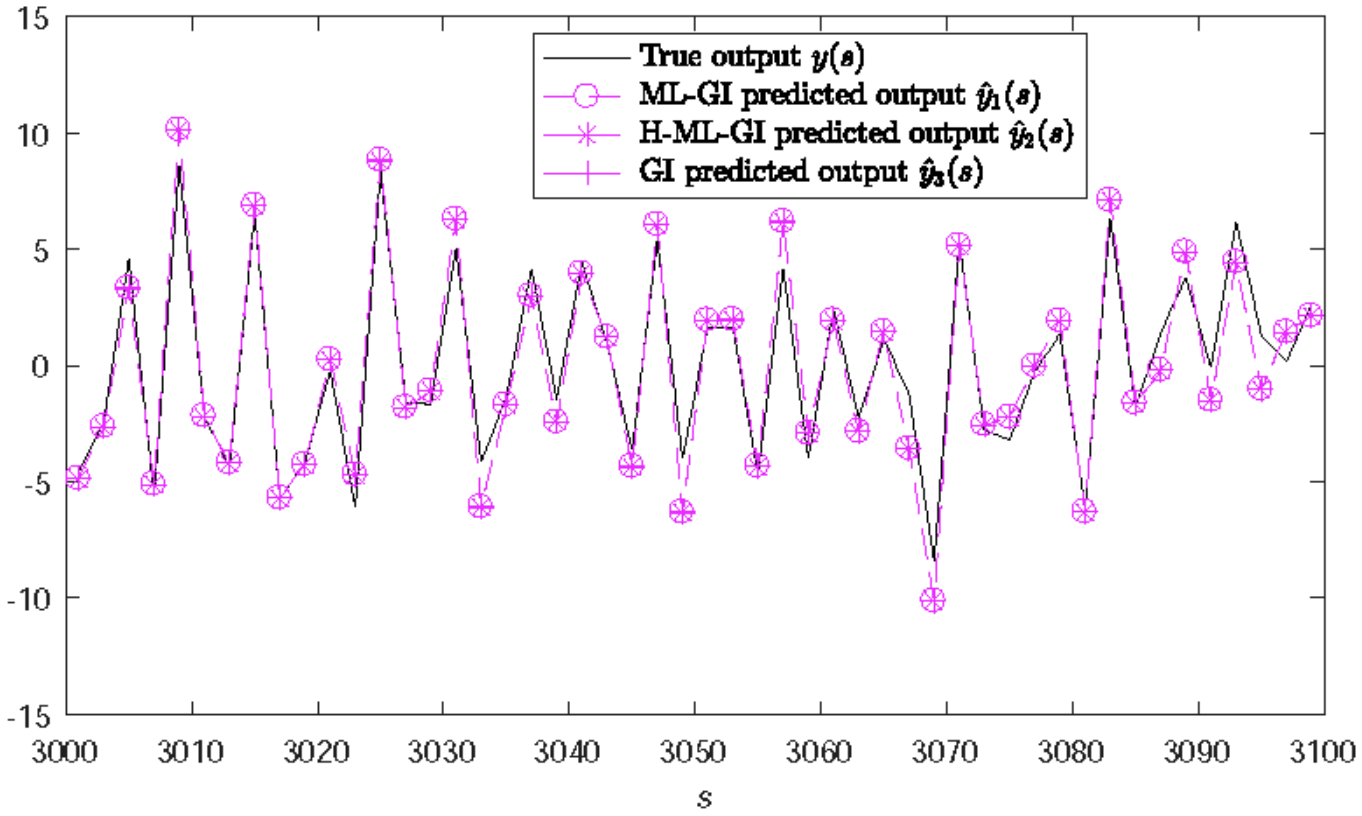

Figure 11

The predicted outputs yi(s) and the true output y(s) versus s with σ2 = 1:002