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A Guaranteed Estimate of the Parameter Reconstruction Error in a Linear Difference System

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Abstract—We consider the problem on reconstructing parameters of a linear autonomous difference discrete-time system from a finite set of approximate observations of the system state. We impose minimal assumptions on the observation error. Namely, we assume that the absolute value of the difference between the state vector and the corresponding observation is componentwise bounded from above by some given constant. Under these assumptions, we propose a theorem on the minimal guaranteed estimate of the parameter reconstruction error and describe the corresponding reconstruction algorithm.

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INTRODUCTION

Dynamic discrete-time models with constant parameters (coefficients) constitute one of most popular (both in theoretical and applied research) class of models. In the linear case, such a model turns into the following system of difference equations:

$$y_t = \sum_{j=1}^{p} B_j y_{t-j} + \sum_{k=1}^{q} D_k u_{t-k} + f_t + \varepsilon_t, \;\; t = 1, \ldots, T. \tag{1}$$

Here the vector variable $y = \mathrm{col}(y_1, \ldots, y_n)$ (the set of endogenous variables) describes the observed state of the model system at time moments t_i; $u = \mathrm{col}(u_1, \ldots, u_r)$ is the set of exogenous variables (including control ones); we assume that the prehistory of all variables is known, namely, $y(\xi) = \varphi(\xi)$, $u(\xi) = \psi(\xi)$, if $\xi < 0$. Models (1) are used so widely, mainly, because the theory of parameter estimation is thoroughly developed for such models; this theory is called the econometrics. Within the econometric approach, one has succeeded to answer many questions directly related to the substantiation and evaluation of applicability of vector autoregression (VAR) models (for example, [1]). Namely, one has developed methods for constructing optimal point and interval estimates for parameters (elements of matrices B_j and D_k) of system (1), procedures for testing hypothesis on the significance of these parameters, and requirements to the initial data which are used for the model identification. The key moment here is the hypothesis of the constancy of model parameters. Models in the form (1) constitute the base of the research tool for information-analytical systems (IAS) developed by the company "Prognoz" in Perm [2]. Note that a more general case of discrete-time models with time-dependent coefficients are considered in the monograph [3]. At that, in the set of models compatible with observed input-output sequences one considers subsets of models with certain specified properties. In addition, one synthesizes equations of protomodels generating corresponding subsets of models for the system under consideration. These models are used, in particular, for studying the so-called development indices of dynamic processes and for correctly formalizing notions of rise and recession. Note that model (1) in the standard econometric interpretation is the observation model, i.e., each

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