

ERRORS-IN-VARIABLES METHODS IN SYSTEM IDENTIFICATION

Torsten Söderström

Department of Information Technology

ts@it.uu.se

The lecture gives a survey of errors-in-variables methods in system identification. Background and motivation are given, and examples illustrate why the identification problem can be difficult. Under general weak assumptions, the systems are not identifiable, but can be parameterized using one degree of freedom.

Examples where identifiability is achieved under additional assumptions are also provided. Such examples include modeling the noise-free input and the measurement noises as ARMA processes. Another possibility is to use multiple experiments, where some conditions on the different experiments have to be imposed.

It will be described how an Cramer-Rao lower bound for the parameter estimates can be computed, and how different estimators may be classified.

A number of approaches for parameter estimation of errors-in-variables models are presented. The underlying assumptions and principles for each approach are highlighted. Approaches covered include the instrumental variable estimator (based on Yule-Walker type of equations, or more sophisticated versions); various bias-compensating methods, where the linear least squares normal equations are complemented with a few more equations to handle the noise contributions; the so called Frisch scheme, applied for identifying a dynamical system; total least squares approaches; prediction error and maximum likelihood methods; and methods designed for using periodic data.

The lecture is primarily based on [1].

References

- [1] T. Söderström. Errors-in-variables methods in system identification. Plenary paper. *14th IFAC Symposium on System Identification*, Newcastle, Australia, March 29-31, 2006.

About the author



Torsten Söderström was born in Malmö, Sweden, in 1945. He received his MSc degree (“civilingenjör”) in engineering physics in 1969 and his PhD in automatic control in 1973, both from Lund Institute of Technology, Lund, Sweden. He is a Fellow of IEEE.

During the period 1967–1974 he held various teaching positions at the Lund Institute of Technology. Since 1974, he has been at Uppsala University, Uppsala, Sweden, where he is a professor of automatic control. During 1975-1998 he was the head of the Systems and Control Group, which now is a part of Department of Information Technology.

Dr Söderström is the author or co-author of many technical papers. His main research interests are in the fields of system identification, signal processing, and control of mechanical systems. He is the author or co-author of four books: “Theory and Practice of Recursive Identification”, MIT Press, 1983 (with L Ljung), “The Instrumental Variable Methods for System Identification”, Springer Verlag, 1983 (with P Stoica), “System Identification”, Prentice-Hall, 1989 (with P Stoica) and “Discrete-Time Stochastic Systems”, Prentice-Hall, 1994; 2nd edition, Springer-Verlag, 2002. In 1981

he was given (along with his co-authors) an Automatica Paper Prize Award. He is an Automatica editor for the area of System Parameter Estimation since 1992.

He has held a number of positions within IFAC, International Federation of Automatic Control, during 1993-2002. He is currently a council member of EUCA, European Union Control Association.