Optimized System Identification

J.-N. Juang[1] and R. W. Longman[2]

[1]*National Applied Research Laboratories, Taipei, Taiwan,* joe@narl.org.tw
[2]*Columbia University, New York, New York, USA*

Various algorithms create a linear state variable model of physical systems from experimental input-output data, e.g. ERA and OKID, and various subspace methods. These algorithms can be very effective, but they do not optimize a specific cost function to obtain their results. Also, they are nonlinear, resulting in biased estimates in the presence of noise. OKID improves this situation by first identifying a Kalman filter which whitens residuals, and then identifying the system. The usual interest in identification is to obtain a model that predicts systems outputs, but using a cost to optimize output error is difficult because of local minima. Here we use quadratic programming to minimize such a cost starting from the OKID result. It is demonstrated that the additional optimization substantially improves both the variance and the bias of identified parameters. Examples are given for a benchmark problem identifying the dynamics of a building, and also identifying the dynamics of a suspension bridge in Los Angeles using data taken during earthquakes.