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Toward a Convergent Entropic Identification Algorithm

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Abstract

An analogy between an entropic identification scheme proposed by Klán and an identification scheme based on an under–determined least–squares formulation is made. This formulation produces an estimate of the parameter vector in an ARMA setting which is of minimum two–norm while satisfying the constraint that the sum of the elements of the parameter vector is equal to one and that the inner product of the parameter and regression vector at any given time is equal to the measured output one time–step in the future.
Continuing along this thread, another formulation is produced, one which is akin to Kaczmarz's method. This formulation provides an estimate of the parameter vector such that it satisfies the same constraints as the previous formulation, but minimizes the two-norm between each successive parameter estimate, providing an additive update of the parameter vector at each time–step. This formulation provides insight into the entropic identification scheme proposed by Klán; namely, that it satisfies similar constraints, but produces a parameter estimate which minimizes an entropic "norm" instead of the standard two–norm. By replacing the entropic "norm" in their algorithm by the Kullback–Leibler metric measuring the distance between discrete probability distributions, an new entropic identification scheme is produced. This algorithm has a number of interesting properties. First, parameter convergence is similar, under certain conditions, to Kaczmarz's method. Second, the parameter update is multiplicative rather than additive. Finally, numerical experiments suggest that the entropic algorithms are less prone to the bursting phenomenon than the least-squares algorithms.

Keywords: Entropy, Identification, Convex Combination, Kullback-Leibler, Kalman Filter

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Dampening Controllers via a Riccati Equation Approach

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Abstract

An algorithm is presented which computes a state feedback for a standard linear system which not only stabilizes, but also dampens the closed–loop system dynamics. In other words, a feedback gain vector is computed such that the eigenvalues of the closed–loop state matrix are within the region of the left half–plane where the magnitude of the real part of each eigenvalue is greater than the imaginary part. This may be accomplished by solving one periodic algebraic Riccati equation and one degenerate Riccati equation. The solution to these equations are computed using numerically robust algorithms.
Finally, the periodic Riccati equation is unusual in that it produces one symmetric and one skew symmetric solution, and as a result two different state feedbacks. Both feedbacks dampen the system dynamics, but produce different closed–loop eigenvalues, giving the controller designer greater freedom in choosing a desired feedback.

Keywords: algebraic Riccati equation, periodic systems, feedback

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The Computation of the Sum of the Positive Eigenvalues of a Pseudo-Hamiltonian Matrix

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Abstract

A pseudo-Hamiltonian matrix is a structured matrix whose trace is equal to zero. In this brief report, a method for computing the sum of the eigenvalues with positive real part is presented. The key to this algorithm is the computation of the positive invariant subspace of the pseudo-Hamiltonian matrix via the QR factorization of the transpose of its matrix sign shifted by the identity matrix. This allows the projection of the pseudo-Hamiltonian matrix to a smaller matrix whose eigenvalues are the eigenvalues of the pseudo-Hamiltonian matrix with positive real parts.

Keywords: Hamiltonian matrices, matrix sign function

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An Algorithm for the Determination of the Model Structure of a Predicted and/or Controlled Process

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Abstract

The problem of model structure determination of an examined process is usually a necessary prerequisite for successful prediction and/or control of the process. In particular, models which may be defined as dynamic, discrete-in-time, input-output, stochastic with normal white noise, parametrized, linear-in-parameters, have traditionally been used to describe an unknown process. Due to the incompleteness of the available information about the process, a certain number of hypotheses about the model structure are formulated and the best (optimal, true) one corresponding to the true model structure, which is supposed to be among them, is sought.
Bayesian statistics has proved to be a useful tool for the theoretical solution of the presented problem; however, the large number of competing hypotheses makes it difficult to ascertain which is the best one. Thus, a special algorithm was developed which searches only a "reasonable" subset of all the hypotheses, from which it tries to find the true model structure of the examined process.

Keywords: Structure determination; Bayesian approach; MIMO model; ARX model

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Comparative Study of Four Adaptive Frequency Trackers

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Abstract

We study and compare four algorithms for adaptive retrieval of slowly time varying multiple cisoids in noise: adaptive notch filter, multiple frequency tracker, adaptive estimation scheme and hyperstable adaptive line enhancer. The local behavior of the algorithms in a neighborhood of their equilibrium state (assuming high signal-to-noise ratio (SNR) and large data sample) for a two–cisoid signal is treated in a similar way to the linear filter approximation technique used for a single cisoid case. Next, behavior of the four algorithms with respect to global convergence and the SNR threshold are examined by aid of computer simulations.

Keywords: tracking, sinusoidal frequency estimation, adaptive filter

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Identification of Parameters of an AR(1)–process with Missing Data

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Abstract

This paper deals with the problem of identification of posterior probability density function of parameters of an AR-process from incomplete data sample. The AR(1)-case is completely solved here. A sufficient statistic is constructed (limited by size of largest "gap" in data) that makes it possible to find an expression for posterior probability density function that is analogous to the complete data case.

Keywords: Bayesian approach; ARX model

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Noninteracting Control of Affine Nonlinear Singular Control Systems

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Abstract

This paper discusses noninteracting control problem for affine nonlinear singular systems. An algorithm is proposed, based on which a sequence of integers can be defined for the system. It is shown that such integers are invariant under the restricted equivalent transformation and the regular feedback. Sufficient and necessary conditions for the solvability of the noninteracting control problem are derived. An example is provided to illustrate the main results.

Keywords: Singular systems, nonlinear control systems, noninteracting control.