Adaptive and Array Signal Processing/Processamento de Sinais Adaptativo

CETUC/PUC-Rio - Prof. Rodrigo de Lamare

Tutorial Questions/Lista de Exercícios - 6

1. Consider a system identification problem as shown below

where is an N x 1 input vector, d[i] is the desired signal, is the measurement noise, is the system to be identified that can be modelled as an FIR filter with N coefficients and is an adaptive filter with N coefficients used to identify . Use complex Gaussian random variables with zero mean and a chosen variance to model , and , define the signal-to-noise ratio (SNR) as appropriate and employ at least 100 repetitions to obtain well behaved curves.

a) Write a Matlab programme to simulate the mean-square error (MSE) curves that describe the learning behaviour of an RLS algorithm.

b) Plot curves for different forgetting factor , SNRs and filter lenghts. What is the effect of large and , high SNRs and large filter lengths on the performance of the LMS algorithm?

c) Compare the simulated MSE curves at steady state with the analytical values available to predict the MSE.

d) Consider a correlated input signal and observe the effects on the MSE curves.

e) Compare the RLS to the LMS and the affine projection algorithms.

2. Consider a network of K nodes

1

k

...

2

K

where at each time instant, each node has access to desired signals and to observation data vectors with N parameters satisfying the measurement model

,

which employs the same N x 1 parameter vector , which can represent information (parameters of the environment, the spectrum, a social network or voltages in a power system) that must be obtained by all nodes, and the complex noise sequences are both temporally and spatially white with variances . The observation data vectors are statistically independent over both time and space and have correlation matrices . It assumed that the network is partially connected and that a diffusion protocol is employed. Each node can run an adaptive algorithm to estimate .

a) Write a Matlab programme to simulate the MSE curves that describe the learning behaviour of an RLS algorithm using the available Matlab programme with the LMS algorithm (check the website).

b) Compare different combination rules, namely, the Laplacian, the nearest neighbour, the Metropolis and the Hastings rules. You will need to look for them in the literature.