TSBK02/TSBK06 Computer Lesson: Linear Prediction

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1 Introduction

The problems for this computer lesson deals with linear prediction. We use Matlab to solve the problems. In order for Matlab to find some of the functions, you must add the course directory to the search path:

```
>> addpath /site/edu/icg/tsbk02/matlab/
```

2 Estimating the auto correlation function

Given a sequence x_n, $n = 1 \ldots N$, the auto correlation function $R_{XX}(k)$ for the source can be estimated by

$$R_{XX}(k) = \frac{1}{N} \sum_{i=1}^{N-k} x_i \cdot x_{i+k}$$

In Matlab, assuming the signal is in the vector x, and that we want to calculate the first M values of the auto correlation function, this is done by

```
>> Rxx = zeros(M,1);
>> for k=1:M
Rxx(k)=mean(x(1:end-k+1).*x(k:end));
end
```

Note that Matlab starts indexing vectors at 1.

3 Linear predictor

Given the auto correlation function in Rxx, the predictor coefficients of an order L predictor can be calculated by

```
>> A=toeplitz(Rxx(1:L))\Rxx(2:L+1)
```

A simple autoregressive test signal can be constructed by filtering white noise. For instance, an AR(2) signal can be made like this:

```
>> x=filter(1, [1 -0.9 0.2], randn(100000,1));
```
Calculate the predictor coefficients for different choices of AR model orders and predictor orders. If the order of the predictor is the same as the order of the AR model, the predictor coefficients should be the same as (or at least very close to) the filter coefficients.

You can of course also construct predictors for real signals, such as the music used in lab 2.

4 Quantization and entropy coding

A complete predictive coder should of course also include a quantizer and maybe an entropy coder. Design a full predictive coder and decoder for your signals. You could use simple uniform quantization and the `huffman` function from lab 1 as entropy coder.

As a starting point you can look at the function skeleton in `pred_coder.m` that can be found in the course Matlab directory. Copy it to your own directory and edit it. Compare the performance (rate and distortion or SNR) of the predictive coder to a coder that just quantizes and source codes the signal.