POLITECNICO DI MILANO

MMSP 2nd Module – Lab3

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Predictive coding

EXERCISE 1

Exercise 1 - Problem

1. Generate 10000 samples of the random process $x(n) = \rho x(n-1) + z(n)$, where ρ=0.95 and $\mathrm{z}(n) \sim N(0,0.1)$.

2. Build a PCM codec. Quantize the signal with a uniform quantizer and R bits. Compute the R-D curve for R=1,2,…,8 bits.

3. Build a predictive codec in open loop. Use the optimal MMSE predictor. Use PCM to initialize the codec.

4. Buid a DPCM codec. Use the optimal MMSE predictor. Use PCM to initialize the codec.

5. Compare the R-D curves for PCM, open-loop DPCM and closed-loop DPCM

Exercise 1 - Hints

1. Uniform quantization: x_q = delta * floor(x/delta) + delta/2.

1. Optimal MMSE predictor for AR(1): x_hat(n) = rho * x(n-1)

2. Pay attention to the difference between closed-loop and open-loop.

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EXERCISE 2

Exercise 2 - Problem

1. Load the stereo file ‘mso.wav’ and define *xl* and *xr* as the left and right channels, respectively.

2. Build a DPCM codec. Quantize the signal with a uniform quantizer and R=1,2,…,8 bits.

   Use the left channel *xl* as the signal and:

   1. xl(n-1)
   2. xr(n)
   3. dummy 5*xl(n)

   as the predictor. Use PCM to initialize the codec.

3. Compute the R-D curve for R=1,2,…,8 bits.

EXERCISE 3

Exercise 3 - Problem

1. Load the stereo file ‘ns.wav’.

2. Build a PCM codec. Quantize the signal with a uniform quantizer and R=1,2,…,8 bits, using *floor, ceil,* and *round* in the quantizer rule.

3. Compute the R-D curve for R=1,2,…,8 bits. What’s wrong?

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EXERCISE 4

Exercise 4 - Problem

1. Load the image ‘lena512color.tiff’.

2. Let *x* be the red channel and *y* the green channel of the image. Quantize y with PCM and DPCM (R=1,2,…,8 bits) using:
   1. Y_hat(n) = a*x(n)+b
   2. Y_hat(n) = randn*x(n) + randn*100

   where ‘a’ and ‘b’ are obtained by linear regression (least squares on y=ax+b). Use PCM to initialize the codec.

3. Compute the R-D curve for R=1,2,…,8 bits.