

Homework Assignment VIII

Reading Assignment: Kuc Chapter 4

1. Consider a uniform quantizer as follows where

$$y = \lceil x/2 \rceil.$$

Reminder: $\lceil x \rceil =$ the smallest integer greater than or equal to x .

- Find the decision boundaries, quantization stepsize, and the quantized levels for the quantizer based on the *ceiling* operator. Sketch the quantizer's input-output relationship.
 - Find the set of reconstructed values $\{\hat{x}_i\}$ using the centroid rule. Find the mathematical expression describing the reconstruction \hat{x} as a function of the quantized signal y .
 - Sketch the quantization error signal $q(x)$ from Part (a) and (b).
 - Find the power of the quantization noise σ_q^2 for this quantizer.
 - Suppose that the reconstruction values are now moved *toward zero* by 1 (moving left when $\hat{x} > 0$ and moving right when $\hat{x} < 0$). Re-sketch the quantization error signal $q(x)$ and compute the power of the quantization noise in this case.
2. Consider the 2-level 1-bit mid-rise quantizer depicted in the figure below.

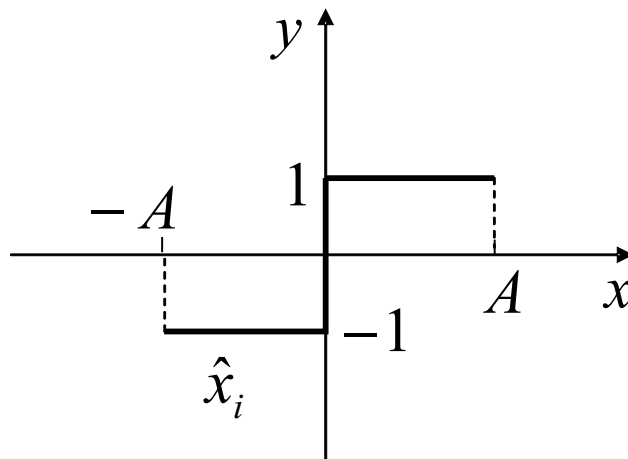


Figure 1: A 2-level 1-bit mid-rise quantizer.

- Find the set of reconstructed values $\{\hat{x}_i\}$ using the centroid rule and sketch the quantization error signal $q(x)$.

- (b) What is the quantization noise power σ_q^2 for the 2-level quantizer in Part (a)?
- (c) Suppose that we do not follow the centroid reconstruction rule and choose the following 2 reconstruction levels $\{-\frac{A}{4}, \frac{A}{4}\}$ instead. Sketch the quantization noise $q(x)$ for this case and recompute σ_q^2 . How does the noise power compare to your answer in Part (b)?

Due date: **Nov. 15** in class