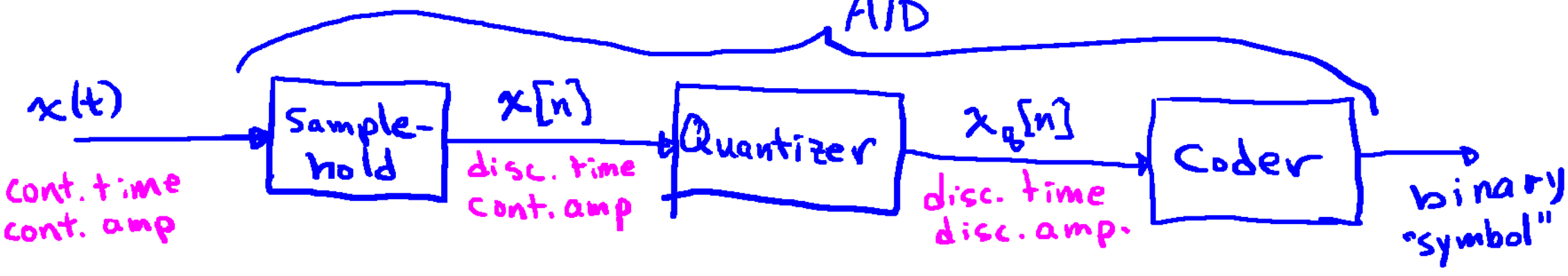
A/D Conversion - Quantization + Coding

Realistic A/D: limited amplitude range
limited set of possible values

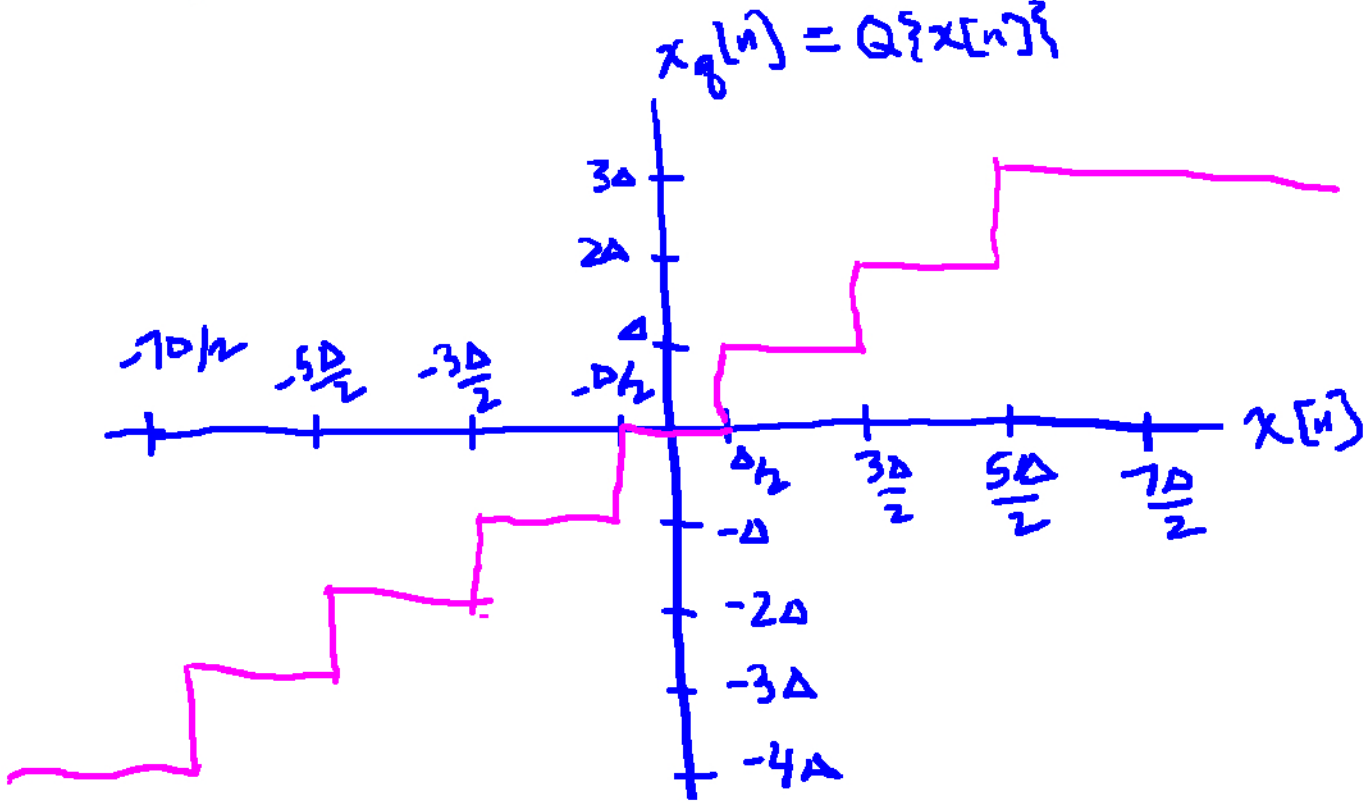
Example: digital camera A/D has 14 bits ⇒
2^{14} possible amplitudes at each pixel



$$x_q[n] = Q\{x[n]\}$$

Quantizers $Q\{\cdot\}$

1) Memoryless – $x_q[n]$ depends only on $x[n]$
2) Time-invariant – $Q\{\cdot\}$ doesnot change with n
3) Uniform – constant step size between levels (Δ)

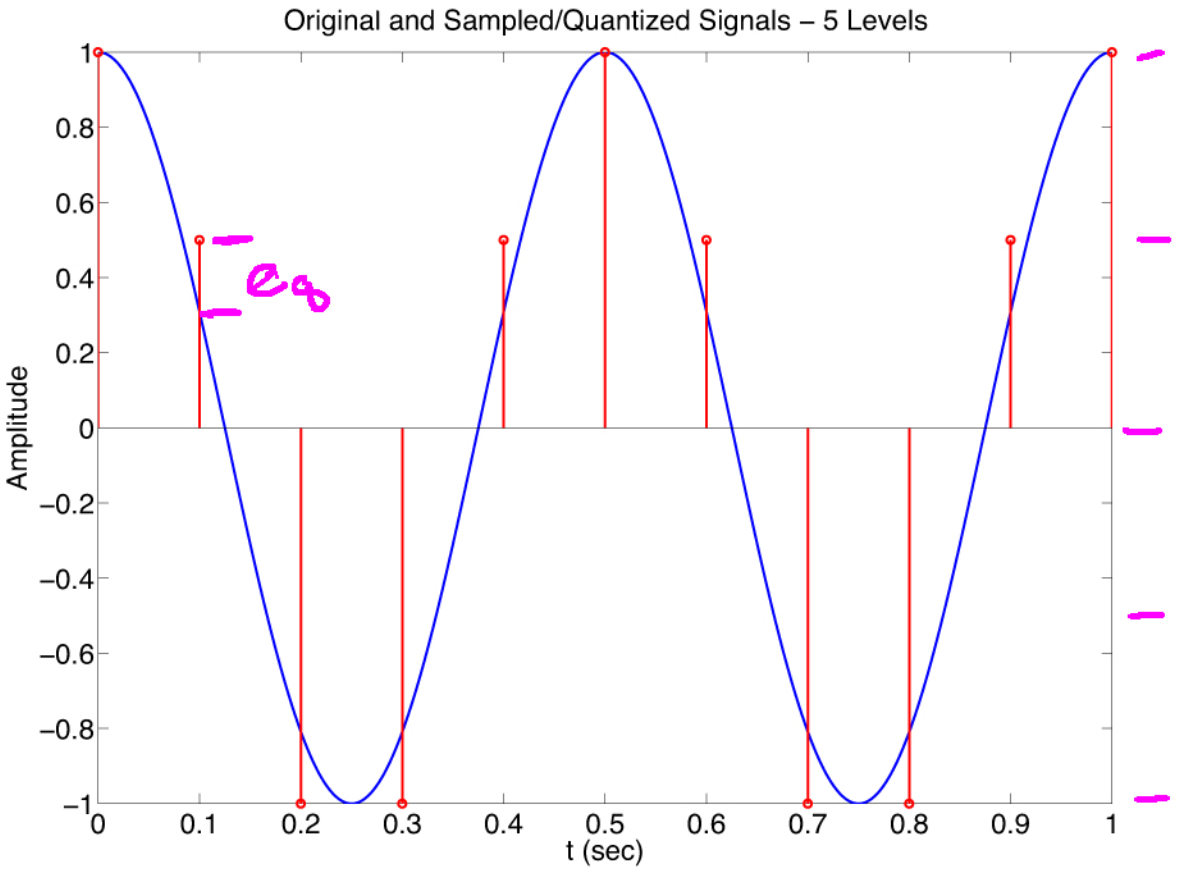


1) Overflow

2) Quant. error

$$e_q[n] = x_q[n] - x[n]$$

$$-\frac{\Delta}{2} \le e_q[n] \le \frac{\Delta}{2}$$


Original and Sampled/Quantized Signals – 5 Levels
Amplitude
t (sec)
1
0.8
0.6
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
−1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

T = 0.1 sec

Coding

Assign a binary number to each quant. level

Examples: 2's complement, sign/magnitude, etc

Given b+1 bits: up to 2^{b+1} quant. levels

If R is range (max - min):

Resolution (step size) $\Delta = \frac{R}{2^{b+1}}$