



Embedded Software

CS 145/145L



Caio Batista de Melo

Announcements



- Project 4 is due tomorrow;
- So is homework 4!
- Next Tuesday, we'll have a guest lecture:
 - Speaker: Dr. Hamid Nejatollahi
 - Topic: Post-Quantum Cryptography
 - Speaker profile: <https://scholar.google.com/citations?user=q3Aba5MAAAAJ&hl=en>
 - Will be on Zoom, I'll share the link in an announcement on Monday;



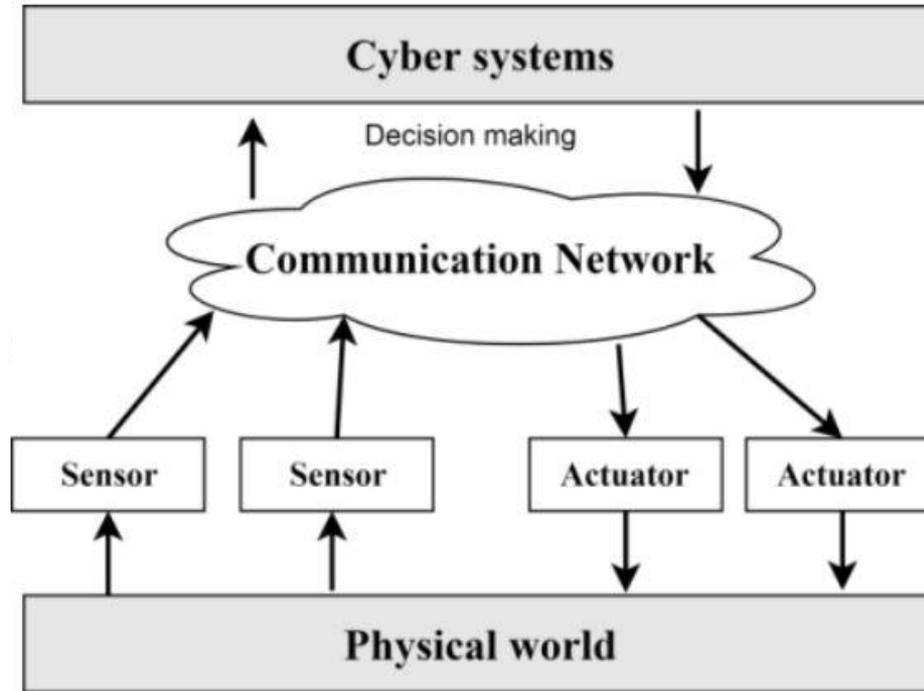
Agenda



- Digital Signal Processing
- Sensors and Actuators
- ADC Recap
- Amplification and Bias
- Approximations



Cyber System and Physical World Interaction

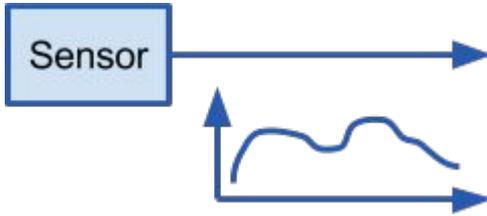


Sensors and Actuators

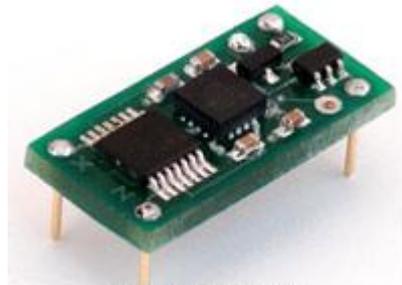
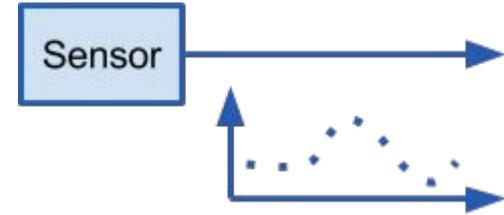
Sensors



Analog



Digital

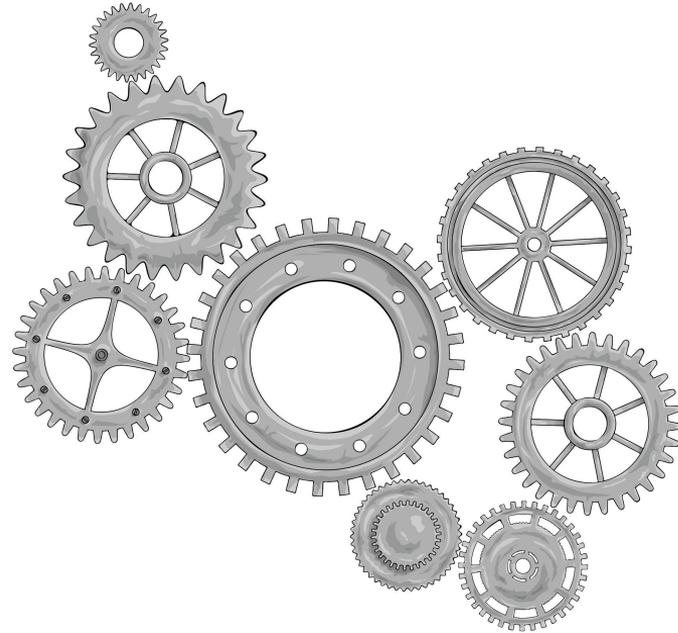
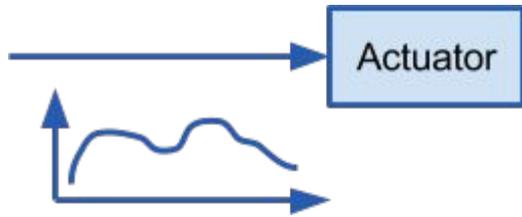


DE-ACCM3D
3 axis accelerometer board

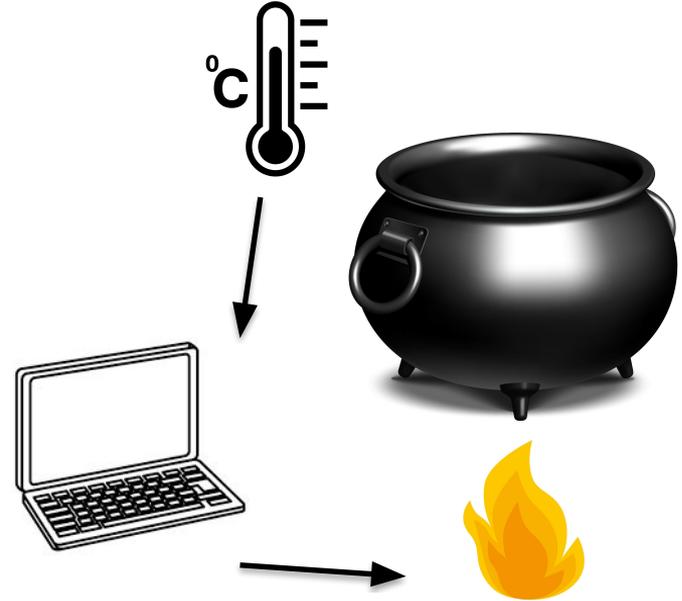
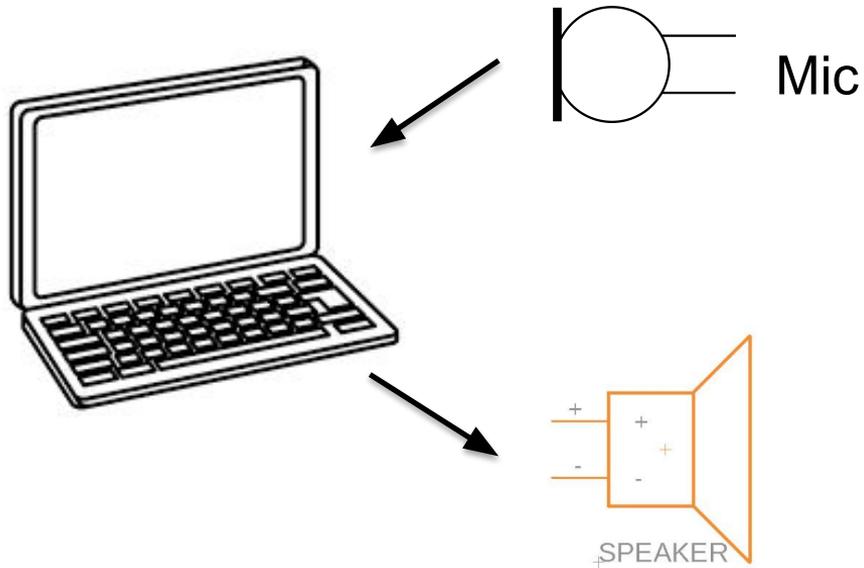
<https://www.dimensionengineering.com/info/accelerometers>



Actuators

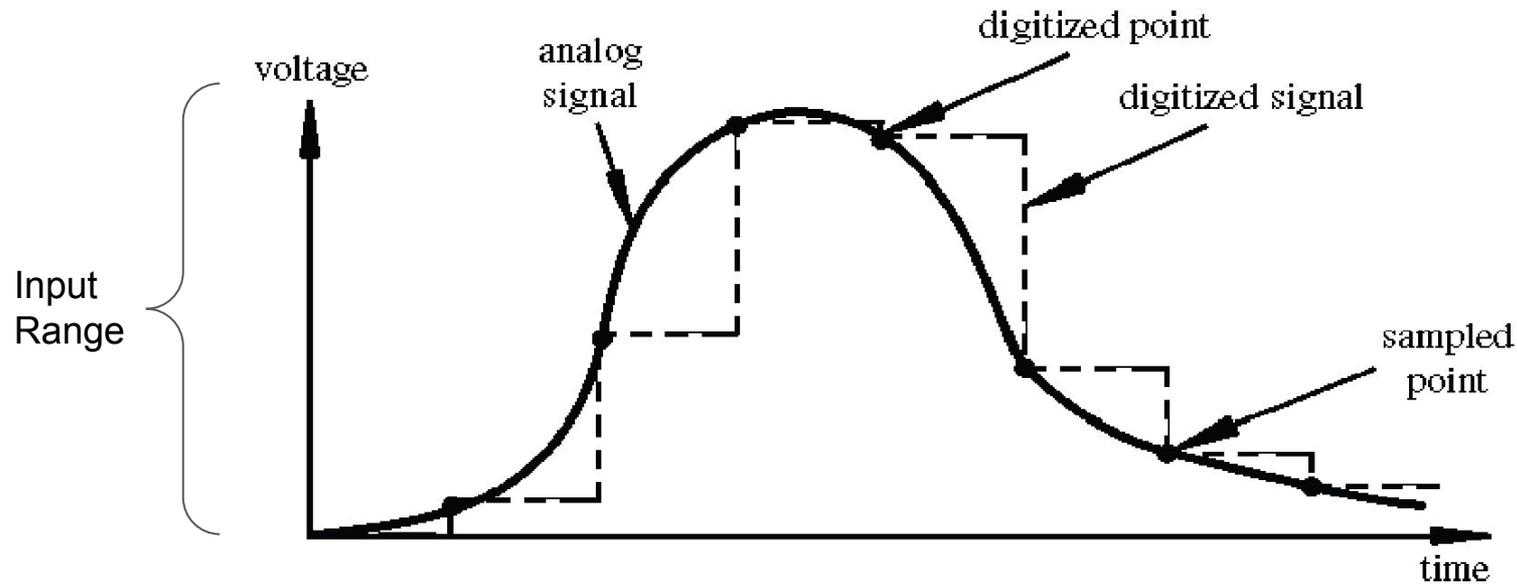


Sensor + Actuator



ADC Recap

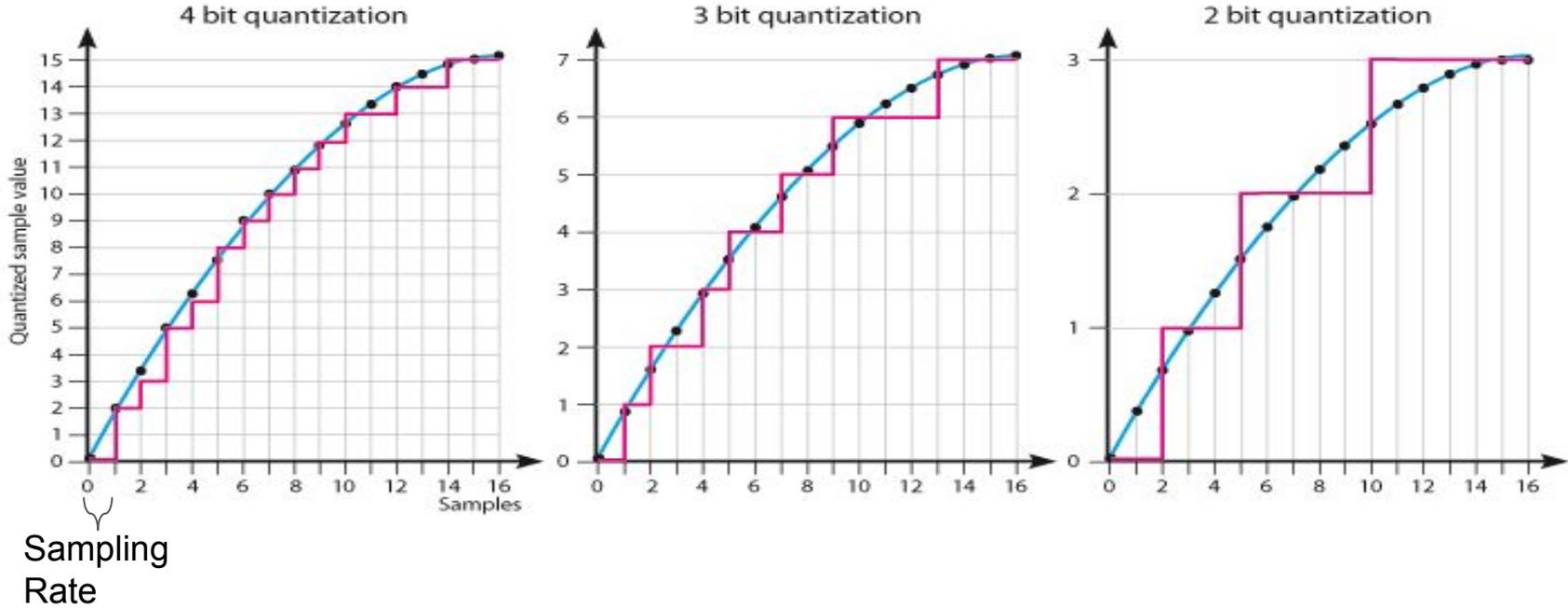
ADC Example



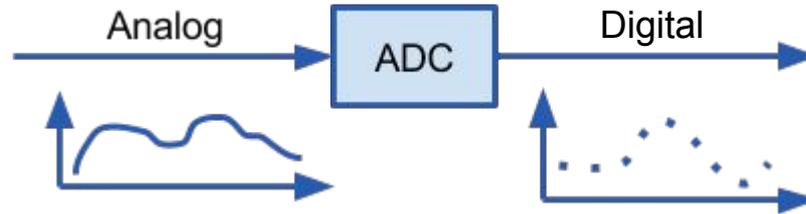
ADC Example



Output Range

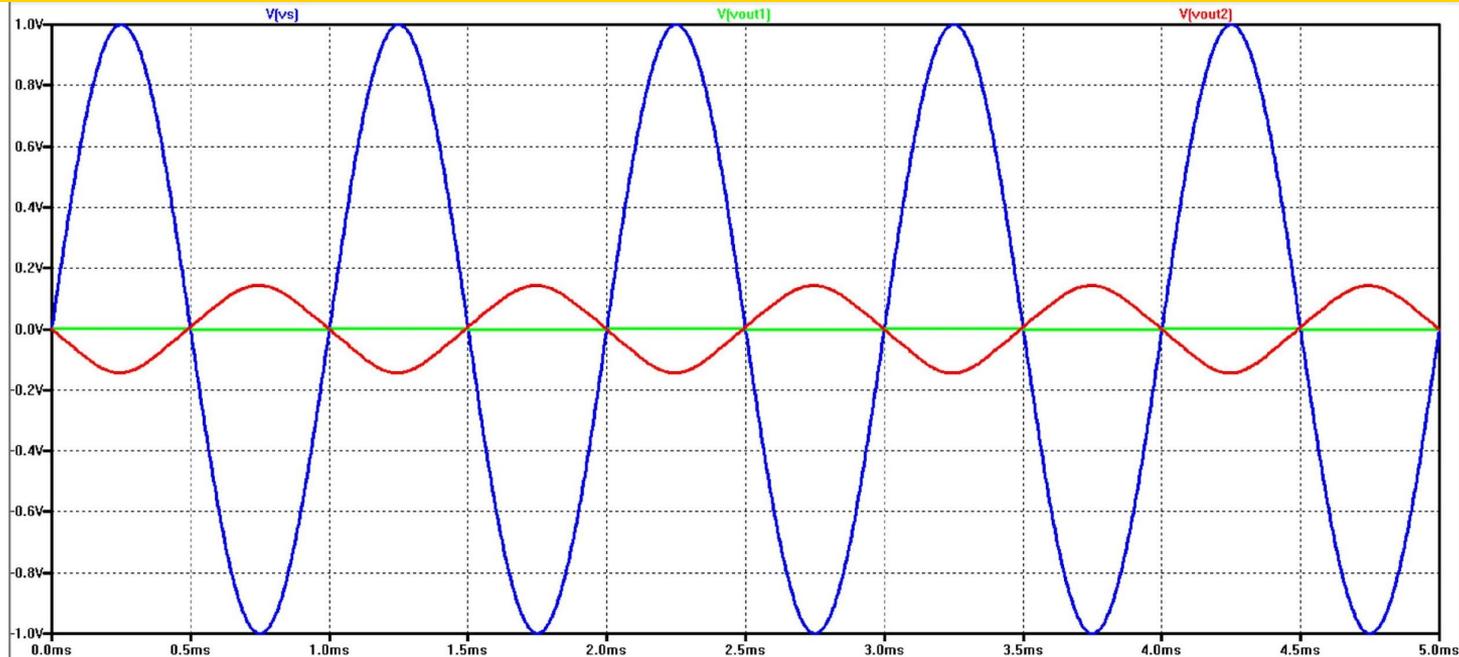


ADC Example



Amplification and Bias

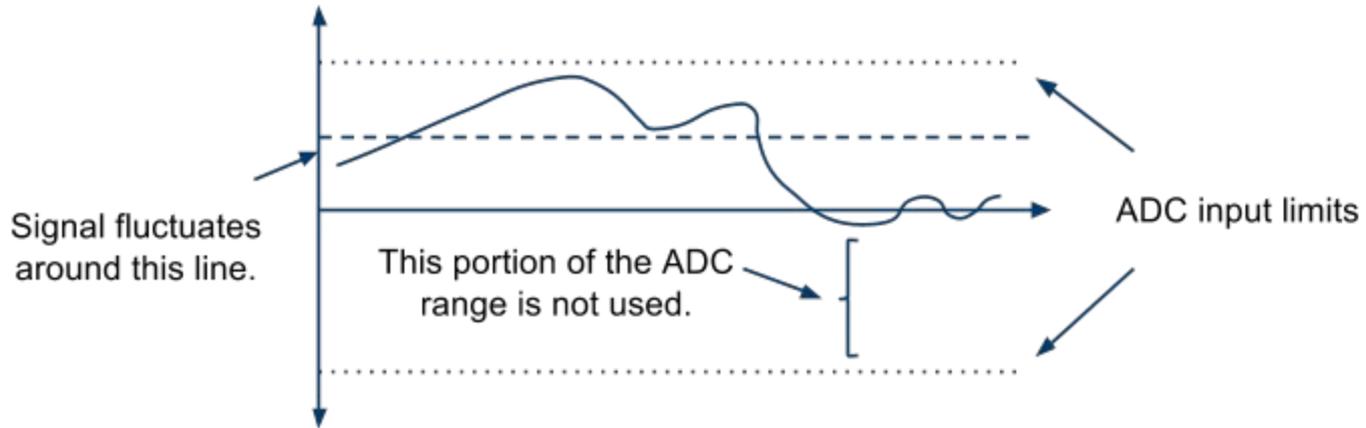
ADC Amplification



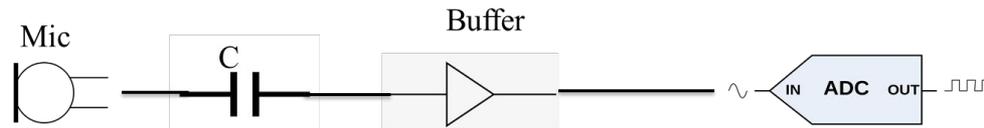
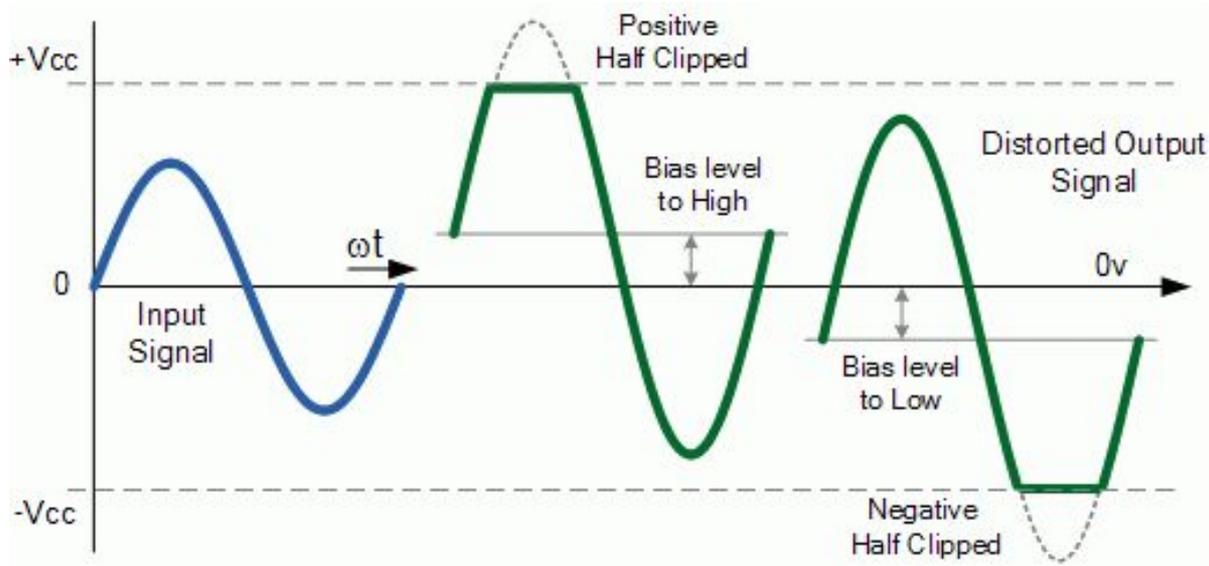
Underutilization or low output (red)
Can increase gain; amplify the signal (page 215 of manual)



ADC Bias

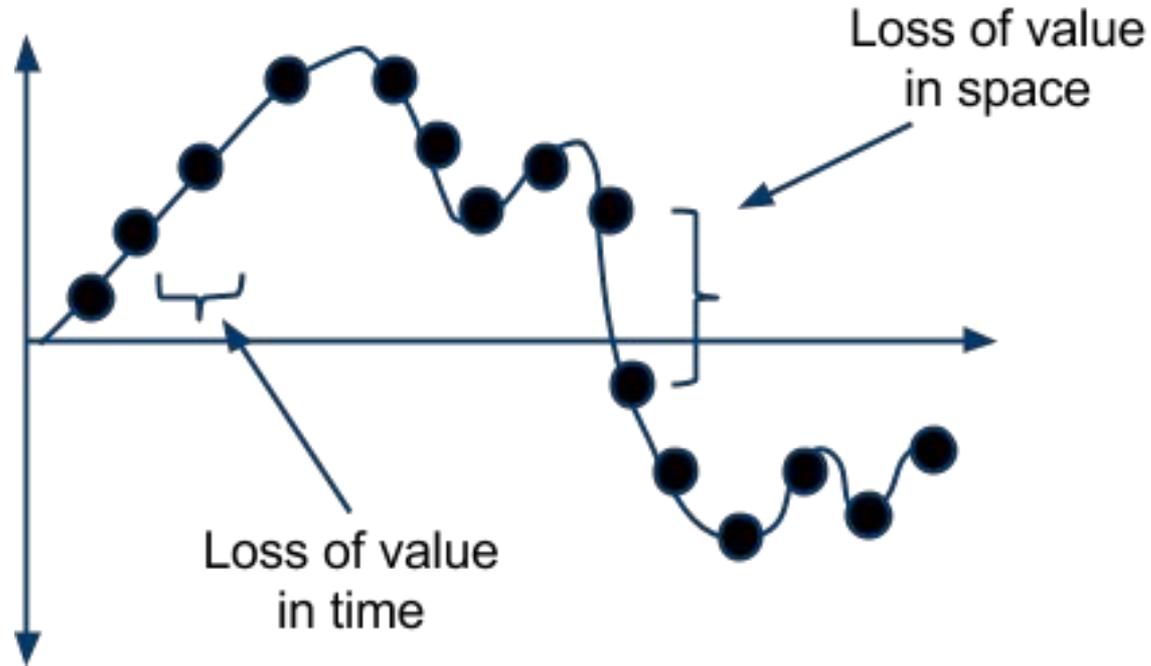


ADC Bias Correction

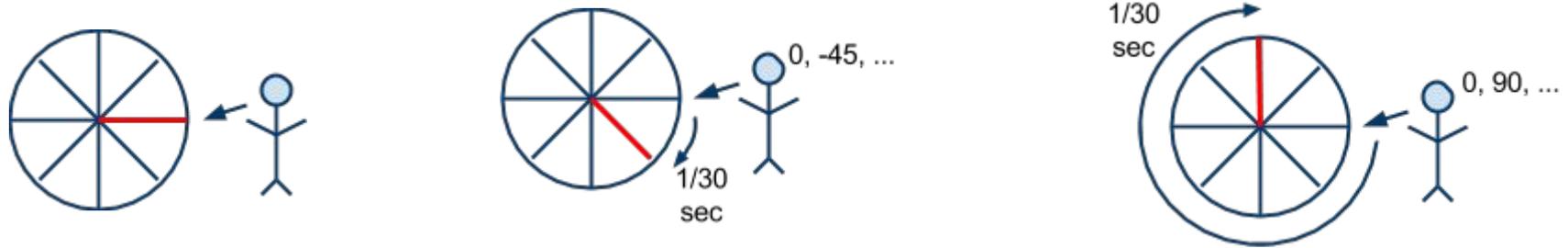


Approximations

Approximations



Sampling Rate



Sampling rate must be at least $2 * \text{max frequency}$ (Nyquist rate);
This rate allows us to see the quickest event that might happen;
Should we sample faster than this?



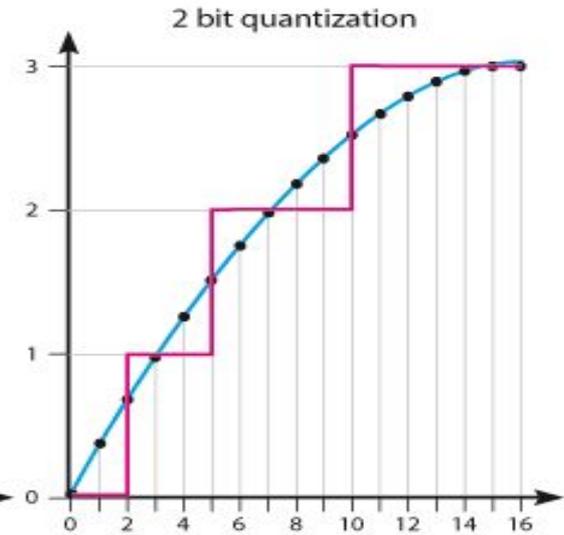
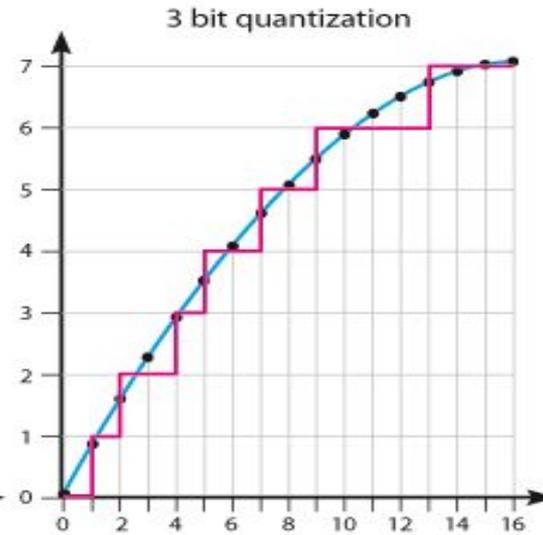
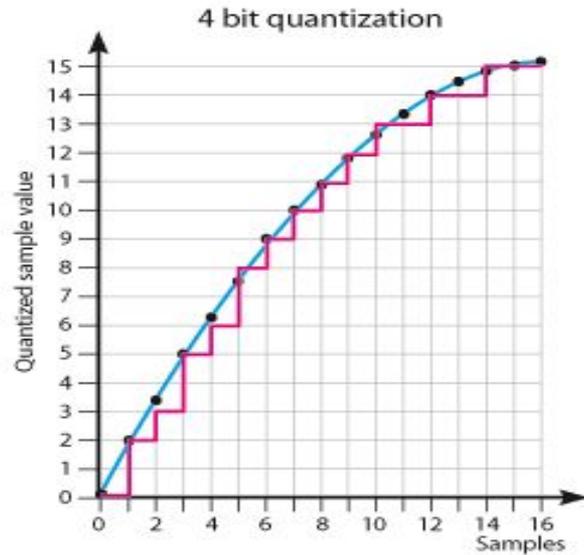
Aliasing Example



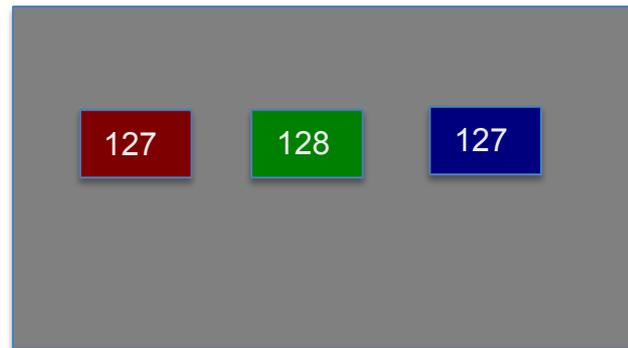
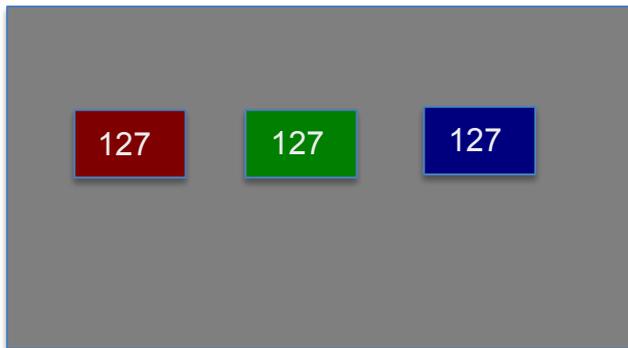
<https://www.youtube.com/watch?v=VXJ0u3ZNdNg>



Quantization



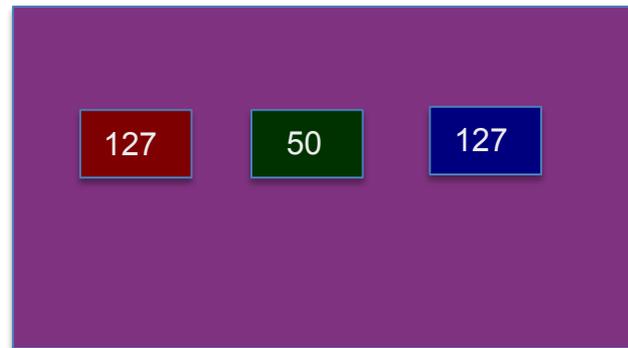
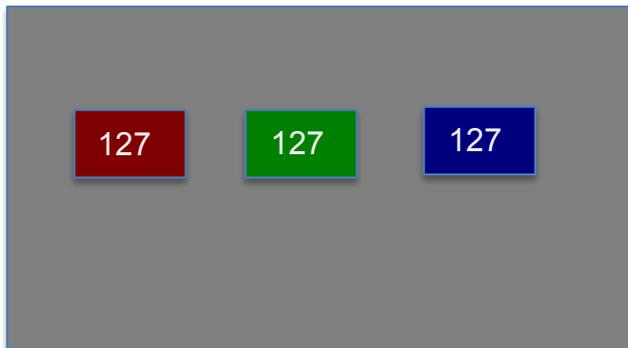
Quantization Example (RGB)



Do you see any difference?
Probably below threshold of perception



Quantization Example (RGB)



Do you see any difference now?
This difference is meaningful!

Should take into account what the user can perceive when choosing the ADC precision;
However, if you already have an ADC, just use max precision.



See you next time :)

Q & A