

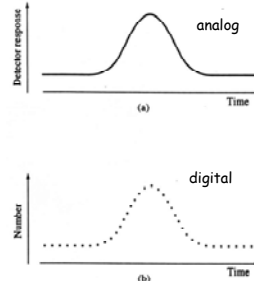
February 2, 2005

- **Transition Week:** Finish *Signals and Noise* and begin **ELECTROCHEMISTRY**
- **Reminder:** Exam #1, Feb. 16th at 7pm!
 - Info page will be posted early next week
 - Email me next week if you have a conflict with the time

1

More Signal Averaging

- **Signal must be digitized** . . . How?
- **Digitization frequency?**
- Nyquist Theorem
- **Precision of digitization?**
- how many bits?
8-bit = $2^8 = 256$ (0.4 %)
12-bit = $2^{12} = 4096$ (0.02 %)

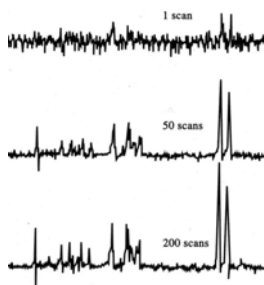


2

Signal Averaging a Spectrum

• Get same S/N enhancement:
- incr. with $n^{1/2}$

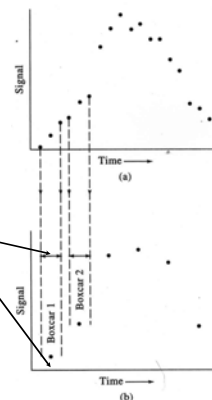
• Need good synchronization for each replicate scan



3

Boxcar Averaging

- Just a **single-channel** signal averager:
- select a single delay time
- integrate signal over selected time gate
- average signal for n-replicates
- repeat at new delay time
- Gives S/N incr. with $n^{1/2}$ for each data point



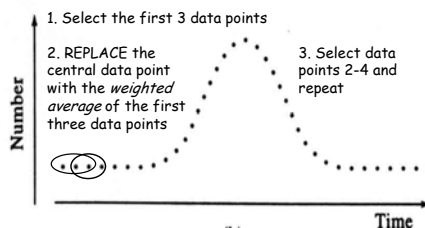
Digital Filtering

- **Can manipulate digitized signals to improve S/N**
- can do this **after** data collection
- don't need a repetitive signal
- **Two methods we'll consider:**
- Savitsky-Golay Smoothing (time domain)
- Fourier Filtering (frequency domain)

5

Savitsky-Golay Smoothing

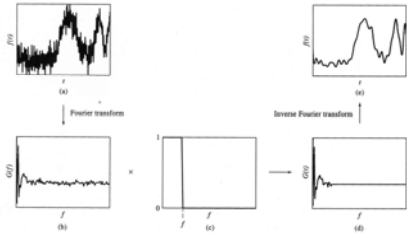
- A **weighted moving average** applied to a series of data. **EXAMPLE: 3-point smooth**



6

Fourier Filter/Smooth

- We would have greater *control* if we were to do this in the *frequency domain*:



7

Beware!

- It is easy to smooth/filter signal as well as noise
 - overlay original and processed waveforms
 - make sure that result is not *distorted*
- Need high point density
 - trade-off between *resolution* and *noise* (high point density = greater Δf)
 - trade-off between *resolution* and *time* (lotsa data points = incr. storage and processing time)

8