

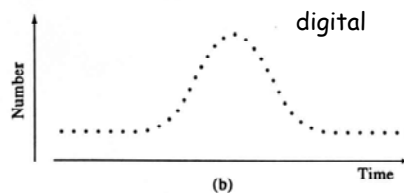
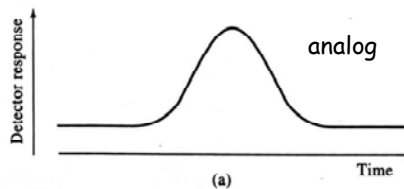
February 2, 2005

- **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

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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 %)



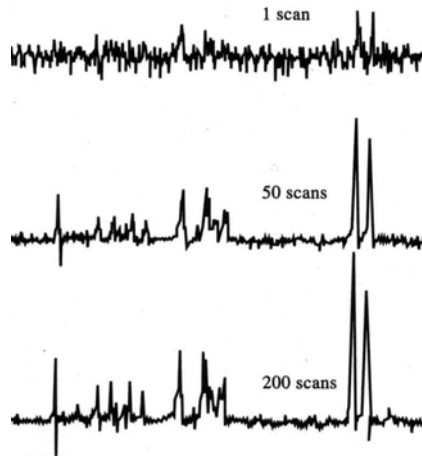
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Signal Averaging a Spectrum

• Get same S/N enhancement:

-incr. with $n^{1/2}$

• Need good *synchronization* for each replicate scan



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Boxcar Averaging

■ Just a *single-channel* signal averager:

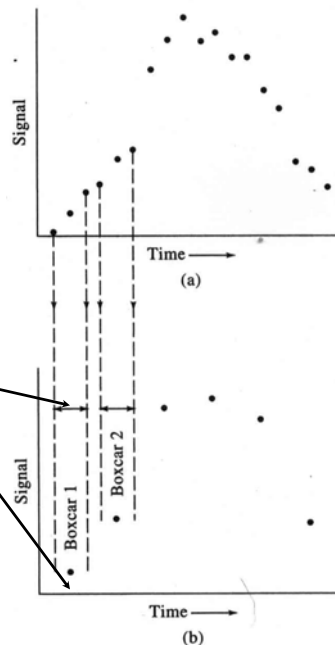
-select a single delay time

-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

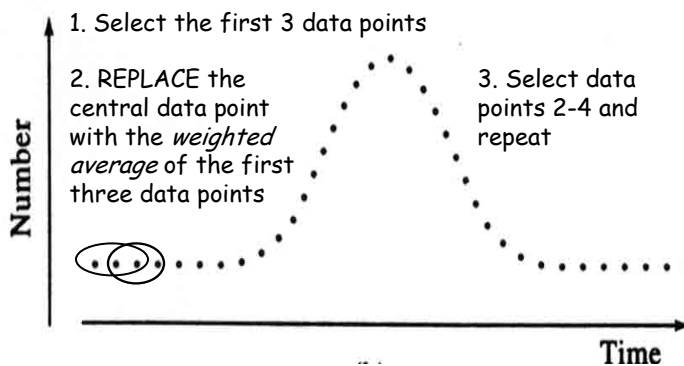
- Two methods we'll consider:

- Savitsky-Golay Smoothing* (time domain)
- Fourier Filtering* (frequency domain)

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Savitsky-Golay Smoothing

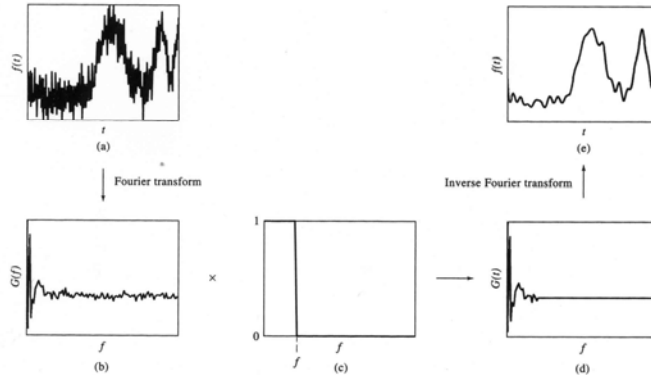
- A *weighted moving average* applied to a series of data. EXAMPLE: 3-point smooth



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Fourier Filter/Smooth

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



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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)

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