



Signal Processing

9-20-2006





Opening Discussion

- Do you have any questions about the quiz?
- What did we talk about last class?





Signal Processing

- The general topic for today is signal processing. This is very important to a number of different scientific fields.
- You already saw some basic signal processing in Chapter 18 on basic data analysis. There you were introduced to the filter function as well as the ltitr function.
- For both of these, the idea is that you want to make new elements that are combinations of elements that had been near them. Filter is sometimes called a moving box filter.



- The most common forms of signal processing are probably those based on Fourier analysis. The idea behind Fourier analysis is that we can express any function as a sum or integral of different sine and cosine waves.
- For a Fourier series we want to express a function $f(x)$ in the following form.

- $$f(x) = a_0 + \sum_{n=1}^{\infty} [a_n \cos(nx) + b_n \sin(nx)]$$



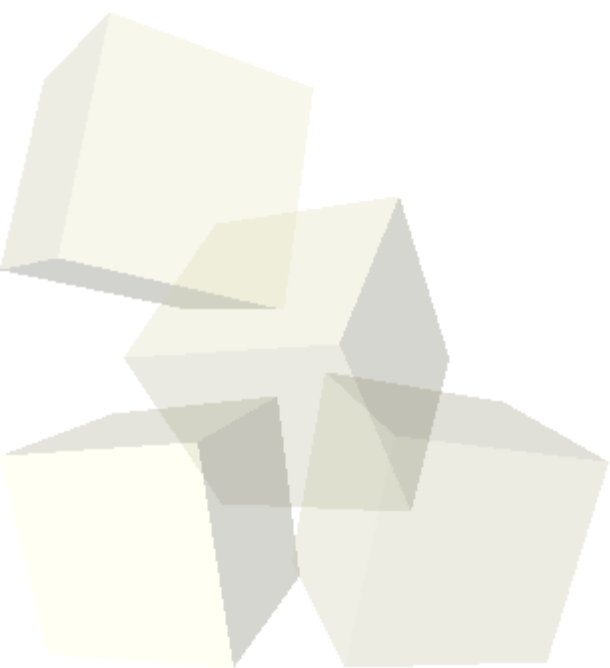
More Fourier Series

- The terms in this are given by the following.

$$a_0 = \frac{1}{2L} \int_{-L}^L f(x) dx$$

$$a_n = \frac{1}{L} \int_{-L}^L f(x) \cos\left(\frac{n\pi x}{L}\right) dx$$

$$b_n = \frac{1}{L} \int_{-L}^L f(x) \sin\left(\frac{n\pi x}{L}\right) dx$$





Complex Exponents of e

- It actually simplified things many times if we don't split the sine and cosine apart and instead use a nice property of complex exponentiation.
- $e^{ix} = \cos(x) + i \sin(x)$
- Matlab uses this form and it is a nice thing to know in general. For Fourier analysis, it turns places where we would have to do two integrals into places where we only do one.





Fourier Transforms

- Matlab doesn't actually solve a Fourier series, instead it solves a Fourier transform. That is a continuous form that uses integrals.





Fast Fourier Transform

- Technically what Matlab uses is a function called a fast Fourier transform. To keep it fast, the number of elements passed into it needs to be a power of 2.
- The fft function will go from a signal series and return a series of the frequencies.
- The ifft function does the opposite.
- Notice that we don't pass in the time values so the indexes are assumed to be the times. We have to scale that back to whatever range we actually want.



Closing Comments

- Remember to read about the FFT capabilities of Matlab for next class.

