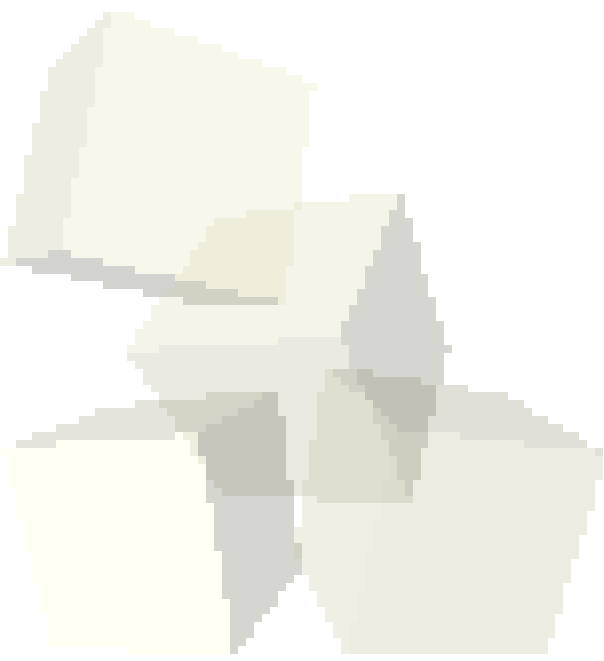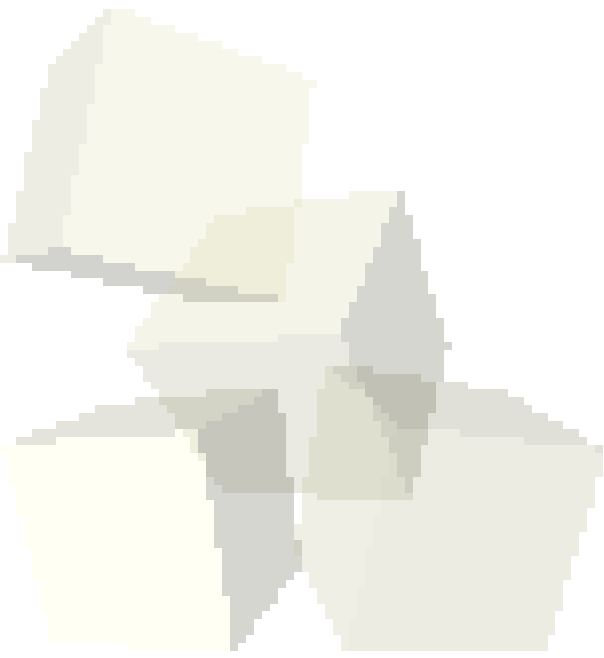2-17-2010

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

- 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.

$$f(x) = a_0 + \sum_{n=1}^{\infty} \left[a_n \cos(nx) + b_n \sin(nx) \right]$$
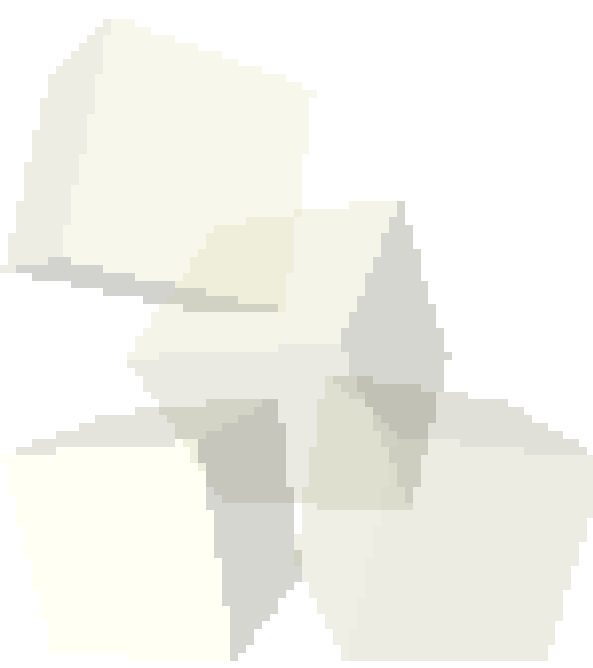
- The terms in this are given by the following.

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

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

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

- It actually simplified things many times if we don't split the sine and cosine apart and instead us 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.

- Matlab doesn't actually solve a Fourier series, instead it solves a Fourier transform. That is a continuous form that uses integrals.
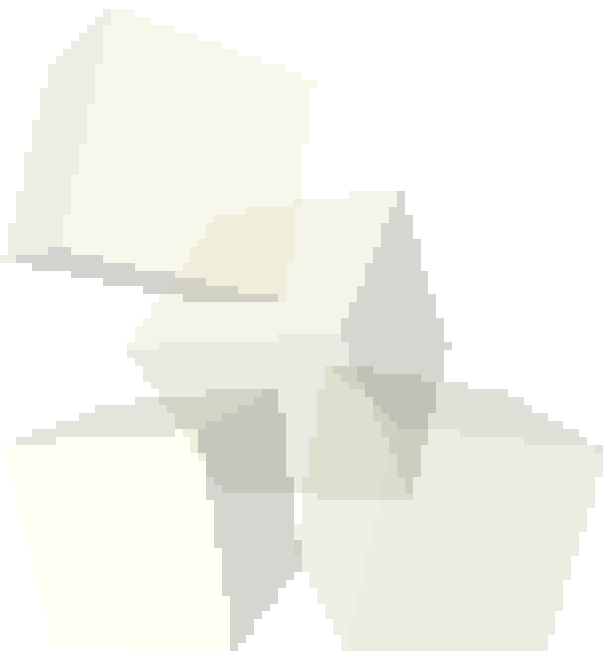
- Technically what Matlab uses is a function called a fast Fourier transform. To keep it fast, the number of elements passed into it needs to be a power of 2.
- The fft function will go from a signal series and return a series of the frequencies.
- The ifft function does the opposite.
- Notice that we 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.
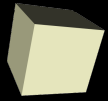
- ■ Remember to read about the FFT capabilities of Matlab for next class.