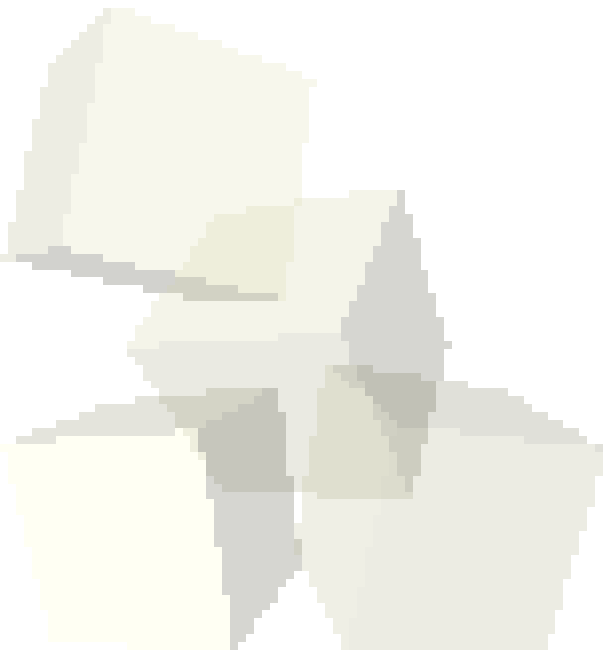




Playing with C and Matlab

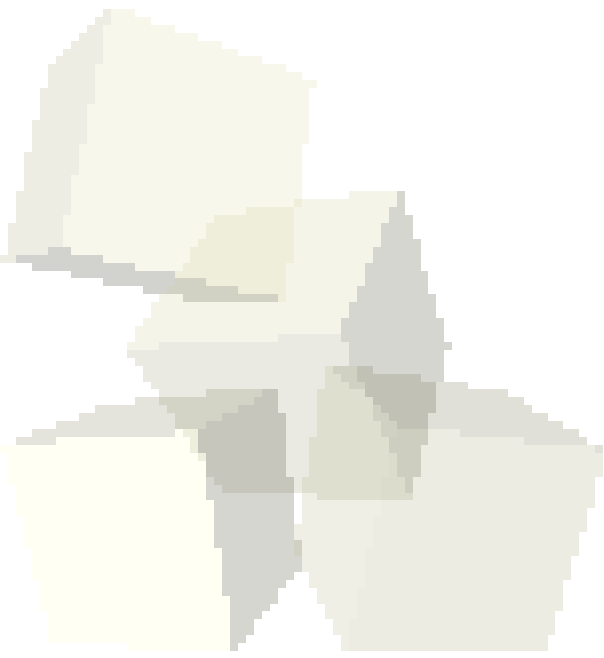
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Opening Discussion

- What did we talk about last class?
- Let's go over the code we wrote last time.





Floating Point Numbers

- Computers represent all numbers in binary (base 2). For fractional numbers we typically use a notation called floating point. This is very much like scientific notation using binary.
- The standard for floating point is IEEE 754. This comes in both single and double precision. Both styles have one bit for the sign followed by bits for an exponent and a fractional part.
- For single precision the exponent gets 8 bits (with a bias of 127) and the fraction/mantissa gets the remaining 23.
- Double precision gets 11 for the exponent (1023 biased) and 52 for the fraction.
- Both assume a leading 1.



Advantages of IEEE 754

- There are some aspects of the floating point representation that are interesting to note. In particular, the differences between integer and floating point representation.
 - ◆ The mantissa has a sign bit instead of using 2s complement.
 - ◆ The exponent has a bias instead of being 2s complement.
- Combined with the ordering of sign, exponent, mantissa you get much faster comparisons.
- The leading 1 makes 0 a special form. Some implementations have unnormalized forms for numbers below the range of the standard.



What it means to you

- The details of IEEE 754 don't matter to most people. What does matter is that these numbers are not the “real” numbers from math.
- Having limited precision means some properties, like associativity, don't always hold.
- The real key is that not all numbers can be represented perfectly. This is similar to the fact that we can't represent numbers like $1/3^{\text{rd}}$ in decimal with a finite number of digits.
- Similarly, there are some types of operations that should be avoided.
 - ◆ Don't subtract two numbers that differ by an amount much smaller than their magnitude.
 - ◆ Don't divide by very small numbers.



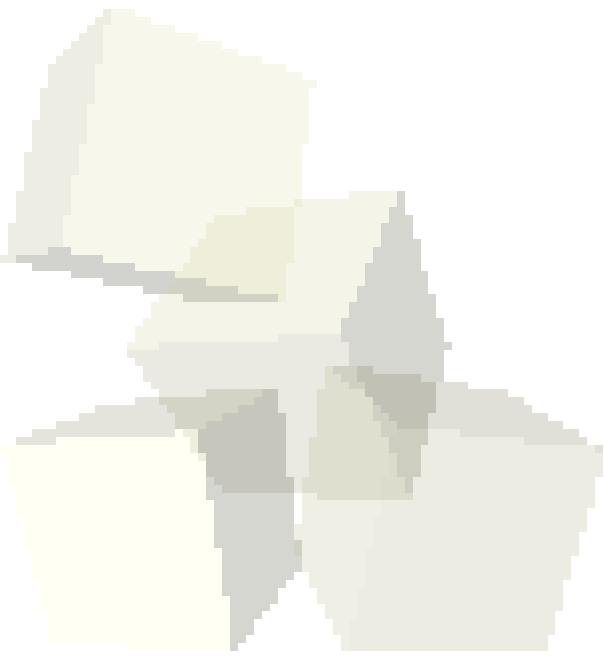
Advantages of Tools

- These rules of thumb are part of the reason many scientists will use tools like Matlab or existing libraries. Often these libraries will use special alternate formulas in situations where the “normal” one is poorly behaved.
- It is often difficult enough just to get the math right without worrying too much about how the numerics will behave.





- Now we want to try to do these same things in Matlab we did in C. We won't get there today, but we can move in that direction.
- Let's begin by creating an M-file just so that we can see how that works.



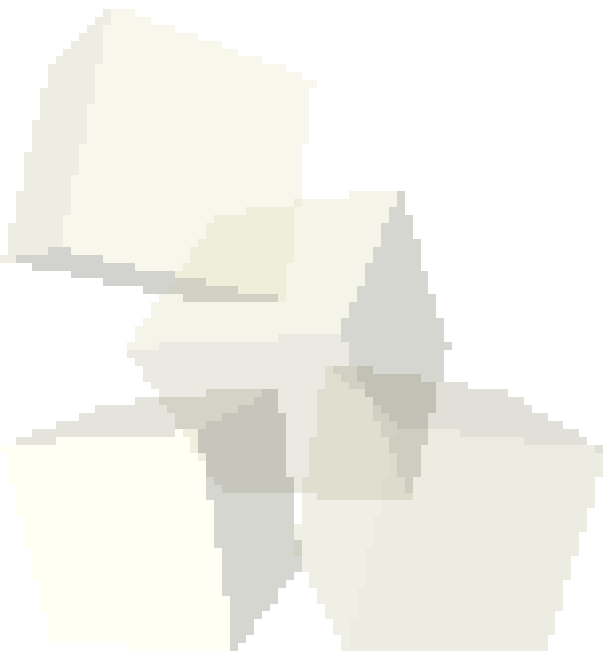


- Matlab was created for playing with matrices, which are basically 2-D arrays.
- Matlab is very good at dealing with arrays and makes it easy to play with them.
- There are lots of ways of building arrays in Matlab and many of the functions in Matlab operate on arrays and return arrays.
- The simplest syntax for creating arrays is with square brackets and space separated values.
- The colon notation is a fast way of building arrays with many elements.
- The linspace function also gives large arrays with linear spacing between elements.



Indexing Arrays

- We use parentheses to pull values out of arrays in Matlab.
- The indexes can themselves be arrays. This method of addressing elements is very powerful and gives us a lot of capabilities in Matlab.
- Let's finish off the day playing with these features in Matlab.





- Do you feel clear on how floating point numbers work on computers?
- We will keep working through material from chapters 4 & 5 next class.
- Also remember that assignment #1 is due on Friday. We'll go over how to turn it in during class.

