More Differential Equations

2/27/2008

Opening Discussion

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

Euler's Method

- Just to help you see how we solve differential equations on a computer, we should look at Euler's method. This is a first order method that you shouldn't use unless you have nothing better to use. It has the advantage of being simple and fast.
- Given the system of equations mentioned before, Euler's method would say the x values are as follows.

$$x_1(t+\Delta t)=x_1(t)+\Delta t * f_1(t, x_1, x_2, .., x_n)$$
$$x_2(t+\Delta t)=x_2(t)+\Delta t * f_2(t, x_1, x_2, .., x_n)$$
$$...$$
$$x_n(t+\Delta t)=x_n(t)+\Delta t * f_n(t, x_1, x_2, .., x_n)$$

Using the ode Functions

- In order to use ode45 or other ODE solving functions, we must define our function in an m-file because we want to pass a handle to it into the ode function. This function should return the derivatives as a column vector.
- If we don't use any return values the function will simply show a plot. A single return value returns a structure. Having two return values gives us the times as well as the arrays of values at each time. That can then be plotted as we see fit.

Examples

- ODEs abound in physics. The simplest ones involve solving the paths of particles interacting through a force like gravity or having masses on springs.
- Population biology can also be expressed as differential equations. Consider things like predator-prey models where how quickly a population changes depends on how much food it has, how many there are now, and how many predators there are.

Multibody Systems as ODEs

- So how do we represent a multibody system as an ODE? What are the variables that we need? What does the system of equations look like?
- The simplest system is probably gravity. Let's set up an N-body gravitational system and solve it with our Eular method and ode45.

Other Examples

- Population biology can also be expressed as differential equations. Consider things like predator-prey models where how quickly a population changes depends on how much food it has, how many there are now, and how many predators there are.
- Chemical reactions can also be nicely modeled with ODEs where reaction rates give you the change in abundance.
- If we go back to chaos examples the Lorenz attractor is a rather famous ODE. We could put that into code and see it as well.

Reminders

- Assignment #5 is due next Monday.