University of California, Irvine Spring 2003

MAE 185 Numerical Methods for Mechanical Engineers

Project #3

Lotka-Volterra Two Species Model

One of the first models to incorporate interactions between predators and prey was proposed in 1925 by the American biophysicist Alfred Lotka and the Italian mathematician Vito Volterra. Lotka-Volterra model is based on *differential equations.*

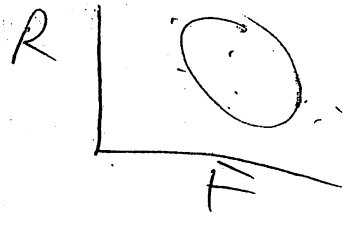
The Lotka-Volterra model describes interactions between two species in an ecosystem, a predator and a prey. This represents our first multi-species model. Since we are considering two species, the model will involve two equations, one which describes how the prey population changes and the second which describes how the predator population changes.

For concreteness let us assume that the prey in our model are rabbits, and that the predators are foxes. If we let *R(t)* and *F(t)* represent the number of rabbits and foxes, respectively, that are alive at time *t*, then the Lotka-Volterra model is:

$$dR/dt = a*R - b*R*F$$
$$dF/dt = e*b*R*F - c*F$$

$R = \frac{c}{d}$; $F = \frac{a}{b} = \frac{0.04}{0.0005} = 80$

$= \frac{0.2}{(0.1)(0.0005)} = 4000$



where the parameters are defined by:

- a is the natural growth rate of rabbits in the absence of predation,
- c is the natural death rate of foxes in the absence of food (rabbits),
- b is the death rate per encounter of rabbits due to predation,
- e is the efficiency of turning predated rabbits into foxes. ?

rate units are universal

Computer Program

1. Using the following parameter values, write down the differential equations for the Lotka-Volterra model.
   - $a = 0.04$
   - $b = 0.0005$
   - $c = 0.2$
   - $e = 0.1$
2. Use the parameter values given above. Write a computer program to obtain the The solution of the Lotka-Volterra's equation. Use fourth order classical Runge-Kutta method with some adaptive step size scheme. Try various initial conditions for the rabbits and fox populations.