Ronney Aovida

11/11/2016

Project Proposal for Computational methods for continuous problems

The project I would like to do my research on is on the predator-prey problem. This is a real life application model I would like to create in order to simulate the results of real life occurrences. The problem is determining the optimal ratio between the prey and predator numbers in a bounded space. Typically in a real life scenario such as an island with a population of Moose and Wolves, I want to determine at what parameters these animals will lead the other to extinction or even themselves, along with determining the most optimal conditions for coexistence. In the program, I will have to create a set breeding time for both the prey/predators, a set starvation time, Number of iterations (how many days it simulates), random movements across the area, a base population and a set size of the bounded space.

How it will work: The program will run a simulation within a bounded space set by the user. The user will then have to set all the parameters such as birth time, starvation time, base population and time for it to run (how many iterations). The program will then print out a visualization for the user to see at each time step of both the prey and predators, when a predator is near a prey by one step size, the predator is then able to eat the prey in order to restart their starvation clock. When the predator or prey want to give birth, whatever open space around them is then used to occupy the new offspring. Each iteration the animals will take a step to a random cell that is open near them. This will run until either the iterations end or one species goes instinct.

The mathematical model used in this simulation is called, Lotka-Volterra.

$$\frac{dx}{dt} = \alpha x - \beta xy \ . \frac{dy}{dt} = \delta xy - \gamma y \ .$$

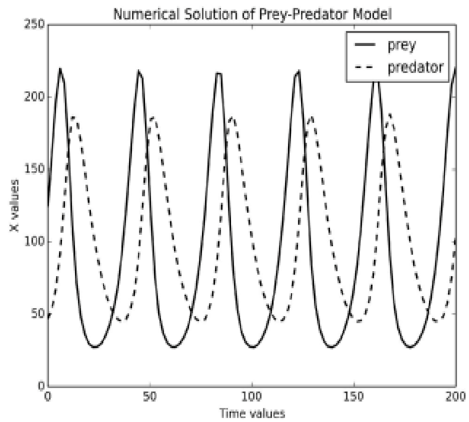
The above equations are relatively simple, they are used to find the derivation of how much the prey population fluctuates and how much the predator population fluctuates. The formula involving dx/dt represents the change in prey whereas the formula involving dy/dt represents the change in predators. In both formulas the variables contain the same meaning, where x is the number of prey, y is the number of predators, t represents time and the Greek symbols (ex.alpha/beta) are all positive real parameters describing the interaction of the two species. In this simulation however we will be representing these parameters as the following: alpha being the growth of the prey through reproduction/survival rate and beta being the rate of death for the prey through being hunted by predators. In the predator equation, delta will be represented by the growth of the predators through breeding and survival rate by consumption of prey, and delta being the rate predators died through starvation.

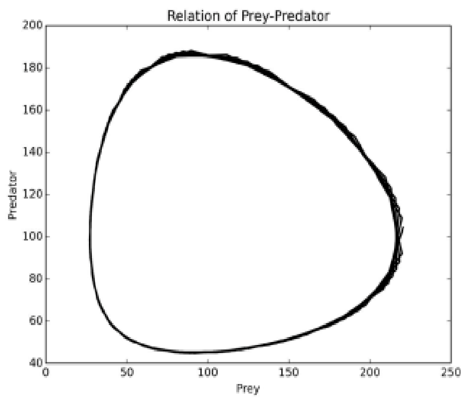
Through these equations we are able to predict the population of a set of predators vs prey as long as the following conditions are taken into account:

- The prey population find ample food at all times.
- The food supply of the predator population depends entirely on the size of the prey population.
- The rate of change of population is proportional to its size.
- During the process, the environment does not change in favor of one species and genetic adaptation is inconsequential.
- Predators have limitless appetite.

Lotka-Volterra graphical representation: (first graph is figure 19.12, second is 19.13)

- "Figure 19.12 shows the graph of the population changes of the prey and predator over time. After 10 seconds, the displacement changes linearly. Figure 19.13 shows the phase plot of the two population changes. Because this a closed curve it implies that the prey and predator populations follow periodic cycles"- cited from: Introduction to Computational Models with Python by Jose Garrido


Numerical Solution of Prey-Predator Model
prey
predator
X values
Time values
250
200
150
100
50
0
0
50
100
150
200


Relation of Prey-Predator
Predator
Prey
200
180
160
140
120
100
80
60
40
0
50
100
150
200
250