MA TH /1/1/7/0

MATHEMATICS FOR LIFE SCIENTISTS

Computer Assignment IV
Due September 23, 2003

We will use Maple to study a nonlinear updating function. The `iread(iter);` command loads a `cobweb` command into Maple, in addition to `iterplot` and `iterplot2`. If you have entered an updating function \( f \) as a Maple function, you can cobweb with

\[
> \text{cobweb}(f, 20, .02, .01);
\]

The first three arguments are like those of `iterplot`: the updating function \( f \), the number of steps (20) and the initial condition (0.02). The last is the domain of the graph (from 0 to 1).

PROBLEM

Exercise 1. We will study the dynamics of selection with mutation, (exercise 1.12.5 in the book), which has updating function

\[
pt_{t+1} = \frac{s(1-\nu)pt + r \mu(1-\nu)}{sp + r(1-\nu)}.
\]

Recall that \( p \) represents the fraction of type \( a \) bacteria in a population, \( s \) is the per capita reproduction of type \( a \), \( r \) is the per capita reproduction of type \( b \), \( \nu \) is the fraction of type \( a \) that mutate into type \( b \), and \( \mu \) is the fraction of type \( b \) that mutate into type \( a \).

Input the updating function as a Maple function (leaving the parameters \( \mu \) and \( \nu \) unspecified). By setting \( \mu \) and \( \nu \) to particular values, we will study the following 4 cases:

- \( s = 2.0, r = 1.0, \mu = 0.0, \nu = 0.0 \) (no mutation).
- \( s = 2.0, r = 1.0, \mu = 0.0, \nu = 0.1 \).
- \( s = 2.0, r = 1.0, \mu = 0.1, \nu = 0.0 \).
- \( s = 2.0, r = 1.0, \mu = 0.1, \nu = 0.1 \).

For each case, do the following:

a. Use Maple to solve for the equilibrium or equilibria (use the `solve` command).

b. Use `cobweb` to cobweb. Choose an initial condition that gives a nice looking graph. Mark the equilibrium or equilibria on your graph.

c. On your last three graphs, write a sentence describing, in biological terms, the ways in which the equilibria and the dynamics differ from the first case without mutation.