Math 151 - Fall 2007 - Project #5

The Leslie Population Model in a Random Environment:

Note: This project is to be carried out independently by each student - you may discuss with other students your ideas for the project, but each person should carry out their own experiment and compose their own report independently of others.

Consider the Leslie model of a population with three classes (call them J for juveniles, Y for young adults, and A for adults) used in Project #4. Suppose the population starts at time zero with 40% in the J class, 35% in the Y class and 25% in the A class and there are a total of 100 individuals present then. Suppose that the population projection matrix is:

$$P = \begin{bmatrix} 0 & 1. & F \\ .5 & 0 & 0 \\ 0 & q & 0 \end{bmatrix}$$

where the parameter q is calculated by
((your age in years)/50 + (the number of your birthmonth)/12) / 2.
Thus if you were born in July of 1980, so you are 26 years old,
q = (26/50 + 7/12) / 2 = .552
(use three significant digits, please). Now suppose the adult fecundity F varies from year to year according to a uniform distribution, with an average value of 5 and with a deviation about that, so that the fecundity varies over the interval (F-deviation, F+deviation) with it having equal chance of being any value in this range.

Making use of the Matlab code in the file ranleslie.m, do the following:
Calculate your value of p and for values of deviation of 1, 2, 3, and 4 do the following:

(a) Determine the population size at the end of a time period of length 101, repeat the experiment 200 times and compute the mean and standard deviation of the population size at time 101, and show a histogram of the population size at time 101.

(b) Determine the geometric mean growth rate of the population's total size by computing this geometric mean over the single time-step growth rates (this is for example N(21)/N(20) for the growth rate from time 20 to time 21) from time 20 to time 100, repeat the experiment 200 times and compute the mean and standard deviation of the geometric mean growth rate, and show a histogram of the geometric mean growth rates.

(c) Summarize your results in a table for the cases of deviation = 1,2,3,4, showing the means and standard deviations computed in (a) and (b), as well as by providing a graph of these results.

Compose a project report that discusses these results by:

(i) Give your methods by showing your value of q, stating in your own words the reason for carrying out this experiment by creating a hypothesis regarding the impact of variation in F on population growth rates, and discussing how this experiment can evaluate your hypothesis. Include

in this a list of assumptions being made in the experiment.

(ii) Discuss your results by referring to the table and associated graph you produced. This should include a one-sentence description of the general result you obtained as shown in the table, as well as several sentences describing in more detail the table and the graphs you produced. In this you should in particular describe how a larger random variation in fecundities affects the population size and the geometric growth rate.

(iii) Evaluate, based upon your results, the hypothesis you made in step (i). Discuss the limitations of the experiment and discuss whether you expect that the results would be applicable to real populations, or what assumptions might be modified to make this a more reasonable method to evaluate the impact of variation on the growth of real populations.

(iv) Include as an appendix your table of results, the graph you produced of these results, and the eight histograms you obtained for population size and geonetric mean growth rates.

This report is due in your TA's mailbox in Ayres Hall by 5PM on Tuesday November 20