

Math151 - Fall 2006 Extra Credit Project

This project is not required for the course - if you choose to complete this project it will only be applied to increase your course grade. If its effect would be to decrease your course grade, it will be ignored. It counts in the overall grading as an additional project, thus it will count a maximum of 4% of your overall course grade. You are required to carry out the work on this project individually, not in a group.

Finding the Maximum Harvest in a Simple Population Growth Case

This project assumes that a population of organisms (think of them as fish in a lake) grows according to a very simple rule: each time period, the population increases by one individual with probability p and decreases by one with probability $1-p$. We will assume that the population is harvested when it reaches a particular number (b) of individuals, and the fraction of the population harvested at that time is f . Thus the amount the population is reduced by harvesting is $f*b$. Further we assume that if the population size drops too low, it will no longer be considered feasible to harvest (below a minimum viable population size which is set at $.1*$ the initial population size), and any harvest obtained in such a population is ignored (e.g. there is a large penalty of getting no harvest if you reduce the population below its minimum viable size).

Your challenge is to investigate how large b can be made for different values of p , to provide the largest mean harvest possible while maintaining the population size above the minimum viable level. You will do this for a particular fixed value of f , that is chosen according to your birthdate as:
 $.6 + ((\text{Your age in years})/200) + ((\text{The number of your birthmonth})/100)$. So if you were born in July of 1980 (so you are now 25 years old) you would choose $f = .6 + 25/200 + 7/100 = .795$

For your particular value of f , assuming the population starts with 100 individuals, do the following:

- (1) For p varying from $.5$ to $.9$ by units of $.1$, find the maximum mean total harvest and the standard deviation of maximum total harvest and the b value used to obtain these, providing a table of your results.
- (2) Plot the values obtained in (1) as a function of p showing in the graph the b value at which maximum mean harvest occurred, and the mean and standard deviation of maximum harvest.
- (3) Interpret your results by describing the relationships you obtained in a few sentences and what you expect to happen when p is too small (below $.5$).

NOTE: I have provided a Matlab program, `harvestopt.m`, to assist you in carrying out this project. This requires you to enter your value of f , the p value, the number of simulations n to be done for each b value (I suggest you set this to at least 25), and the lower and upper values for b to use. The program automatically divides the range of b values you gave into 10 equal sections and calculates the mean and standard deviation of total harvest as well as the mean and standard deviation of the number of harvests at each of the b values. In using this, for each p value be sure to vary the range of b values so as to make sure you find the maximum. The program graphs first the mean and standard deviation of the number of harvests for each b value and then the mean and standard deviation of the total amount of harvest for each b value.