Genome 562 Population Genetics
Winter, 2017 J. Felsenstein

Homework 3
due Wednesday January 25, 2017

Do these problems, and email the results (if you can, in a PDF or else in Word .DOC or .DOCX format). Like all of the weekly homeworks this one totals 25 points and is due at the end of that day (at midnight).

1. (13 points) A locus in an infinitely large population has two alleles and the fitnesses of its genotypes are

Genotype	AA	Aa	aa
Fitness	1	1.02	1.06

We want to know how many generations it will take to change from an initial gene frequency of 0.01 for allele a to a gene frequency of 0.99. (There is no known formula for calculating this, so we resort to putting bounds on it).

(i) Find a set of fitnesses that are multiplicative (geometric), in which the fitness of AA is 1, and the other fitnesses are larger than these actual fitnesses, but are as small as possible.

(ii) How many generations will it take to change from $p_a = 0.01$ to $p_a = 0.99$ with those fitnesses? Will this be lower than the value for the actual fitnesses?

(iii) Find a set of fitnesses that are multiplicative (geometric), in which the fitness of AA is 1, and the other fitnesses are smaller than (or equal to) these actual fitnesses, but are as large as possible.

(iv) How many generations will it take to change from $p_a = 0.01$ to $p_a = 0.99$ with those fitnesses? Will this be higher than the value for the actual fitnesses?

(v) Write a small program in R, or in BASIC, or MATLAB, or Mathematica, or using a spreadsheet or a programmable calculator, or anything, to iterate the gene frequency equations for the actual fitnesses. (You don't need to show me the program). How many generations does it take to get just past 0.99? Do the upper and lower bounds do a good job of informing us about that?

2. (12 points) An infinitely large population has a locus with two alleles. It has two generations per year, one in the spring and one in the fall. The fitnesses of the genotypes are:

Genotype	AA	Aa	aa
Fitness in spring	1.01	1	1.005
Fitness in fall	1	1	0.992

(i) If allele A starts out at a low frequency, how will it change? Will it show an increase or a decrease in gene frequency each year?

(ii) If it starts out at a high frequency, how will it change? Will it show an increase or a decrease in gene frequency each year?

(iii) If it starts out with an intermediate gene frequency (not exactly 0.5), what do you think will happen? Why? (I am not assuming that you will be able to show exact algebra justifying your views).