Stat 536 Homework 10

due: 11/17/08

1. [10 pts] Felsenstein Chapter 8 Exercise 4.

Solution:

In this case, $a = \frac{1}{4}, b = c = \frac{1}{2}, d = 1$, so the roots at equilibrium are (note there is an error in Felsenstein's eq. (VIII-36))

$$D = \pm\frac{1}{4}\sqrt{1 - \frac{4rd}{(1/4)}} = \pm\frac{1}{4}\sqrt{1-16r}$$

If $r < 1/16$, then stable linkage disequilibrium is possible. If $r > 1/16$, then linkage disequilibrium cannot persist.

2. [10 pts] Felsenstein Chapter 8 Exercise 5.

Solution:

In a balanced lethal system, $a = b = c = 0$ and $d = 1$, so

$$D = \pm\frac{1}{4}\sqrt{1-4r}$$

There is linkage disequilibrium if $r < 1/4$, so LD extends much further in such a system.

3. [10 pts] The following two locus data was presented in class.

	$B-$	bb	a_B
$C-$	**95**	**90**	**2.5**
cc	**38**	**34**	**2**
a_C	**28.5**	**28**	

where a_B and a_C are the normalized genotypic values of the dominant phenotypes at each locus. We used this data to argue that the loci contributed additive effects to the genotypic value (number of pigment granules per unit of hair). Assume both genes c and b are recessive and calculate the mean granule count in a HWE population with $p_b = 0.3$ and $p_c = 0.2$ the frequencies of the two recessive alleles.

Solution:

Mean granule count is

$$\begin{aligned} G &= 34p_b^2p_c^2 + 90p_b^2(1-p_c^2) + 38p_c^2(1-p_b^2) + 95(1-p_c^2)(1-p_b^2) \\ &\approx 92.27 \end{aligned}$$

4. **[10 pts] Compute the breeding value and dominance deviation for the** *bbcc* **genotype in the above problem. Also report the *absolute* breeding value of this genotype in units of granule numbers (i.e. not normalized by population mean).**

Solution:

Transform to a, d scale, recognizing that both B and C are considered dominant alleles.

$$
\begin{aligned}
a_b &= \frac{95-90}{2} = 2.5 \approx \frac{38-34}{2} = 2 := 2.25 \\
d_b &= a_b \\
a_c &= \frac{95-38}{2} = 28.5 \approx \frac{90-34}{2} = 28 := 28.25 \\
d_c &= a_c
\end{aligned}
$$

The breeding values for alleles b and c are $2\alpha_i, i \in \{b, c\}$, where α_i is the average effect of gene i. As per notes, these are

$$
\begin{aligned}
\alpha_b &= -(1-p_b)[a_b + a_b(2p_b - 1)] = -0.945 \\
\alpha_c &= -(1-p_c)[a_c + a_c(2p_c - 1)] = -9.04
\end{aligned}
$$

Since the loci are assumed additive, the overall breeding value of *bbcc* is

$$2\alpha_b + 2\alpha_c = -19.97$$

On the absolute scale this is

$$-19.97 + 92.27 = 72.3$$