Math 151, Spring 2011
Jo Hardin, HW #4

Homework due on THURSDAY, FEBRUARY, 10TH, START OF CLASS.

1. DeGroot (3^{rd} or 4^{th} ed.), section 2.1: # 6, 8, 16

   - 2.1 # 16: Consider again the shopper described in Exercise 4. On each purchase, the probability that he will choose the same brand of toothpaste that he chose on his preceding purchase is 1/3, and the probability that he will switch brands is 2/3. Suppose that on his first purchase the probability that he will choose brand A is 1/4 and the probability that he will choose brand B is 3/4. What is the probability that his second purchase will be brand B?

2. DeGroot (3^{rd} or 4^{th} ed.), section 2.2: # 13, 14, 15, 16

3. DeGroot (4^{th} ed.), section 2.3: # 6, 12, 15 (3^{rd} ed., section 2.3: # 10, 16, 19)

4. Additional problem in R: Even more Hardy-Weinberg equilibrium
   # Three genotypes: $P(AA) = p = PAA, P(Aa) = 2 * q = PAa, P(aa) = r = Paa$;
   # Note that $r = 1 - p - 2 * q$

```
calcnextgen = function(PAA, PAa, Paa, u=1, v=1, w=1) {
   PAA2 = u*(PAA*PAA*1 + PAA*PAa*.5 + PAa*PAA*.5 + PAa*PAa*.25)
   PAa2 = v*(PAA*PAa*.5 + PAa*PAA*.5 + PAA*Paa*1 + Paa*PAA*1 +
            PAa*PAa*.5 + Paa*PAa*.5 + PAa*Paa*.5)
   Paa2 = w*(Paa*Paa*1 + Paa*PAa*.5 + PAa*Paa*.5 + PAa*PAa*.25)
   # need to normalize probabilities if some aren't surviving to reproduce
   return(c(PAA=PAA2, PAa=PAa2, Paa=Paa2)/sum(PAA2+PAa2+Paa2))
}
runsim = function(startvalues, numiter=5, lwdval=2, uval=1, vval=1, wval=1) {
   # initialize place to stash results
   results = matrix(rep(0, 3*numiter),nrow=3)
   # snag starting values
   results[,1] = startvalues
      for (i in 2:numiter) { # generate next generations
    results[,i] = calcnextgen(results[1,(i-1)], results[2,(i-1)],
      results[3,(i-1)], u=uval, v=vval, w=wval)
   }
   # display results
   plot(c(1,numiter), c(0,1), type="n", xlab="iteration", ylab="probability")
   lines(1:numiter, results[1,], col="black", lwd=lwdval)
   lines(1:numiter, results[2,], col="red", lwd=lwdval)
   lines(1:numiter, results[3,], col="green", lwd=lwdval)
   legend(1,0.9, legend=c("PAA","PAa","Paa"), col=c("black","red","green"),
     lty=rep(1,3), lwd=lwdval)
}
startvalues = c(0.5, 0.25, 0.25)   # change these
runsim(startvalues)
title("Hardy-Weinberg equilibrium (no selection pressure)")
```

(a) What is the behavior when you set the starting values to 0.36, 0.48, 0.16? (This is equivalent to setting theta=0.6). Explain.

(b) What is the behavior when you set the starting values to 0.5, 0.4, 0.1? What are the equilibrium values? (Calculate the equilibrium values by hand and use the plot to check.)

(c) What is the behavior when you set the starting values to 0.5, 0.4, 0.1, but u=0.9? (Run this for 5 then 200 iterations [call `runsim()` with the option `numiter=200` and `uval=0.9`].) Explain.

(d) What is the behavior when you set the starting values to 0.5, 0.4, 0.1, but v=0.9? (Run this for 200 iterations.) Explain.