Homework 2. Exploring distributions and nonlinear functions.

(1 – 10 pts)
The file “heat_shock_survival.csv” has the results of a large number of experiments where silverleaf whiteflies were given a heat shock treatment, and the researchers recorded how many of the flies survived (data from the attached paper by Diaz et al. 2014). Let’s ignore the experimental structure and just look at the distribution of survival across all the replicates. The column “n” lists the number of flies in each experiment (it’s always 10). The column “Survival” lists the number of survivors for each experiment.

Make a plot with one column and two rows. On the top row, make a histogram of # survivors across all experiments.

On the bottom row, make a plot of the expected probabilities for a binomial distribution with $n = 10$ and with p equal to the mean proportion of survivors across all experiments (you will need to calculate this mean). You can calculate the expected binomial probabilities using dbinom(). The argument “size” is how you specify the number of trials (n), and the argument “prob” is how you specify the probability of survival (p). The argument “x” is the number for which you want to find out the corresponding probability, i.e. if you set $x = 1$, you are asking what is the probability that there will be 1 survivor.

How would you characterize the similarities and differences between the observed distribution and the predicted distribution from the binomial function? If $n = 10$, and p = the observed mean proportion of survivors, what is the variance of the corresponding binomial distribution (the formula is in the lecture notes, or on Wikipedia)? What is the variance in #survivors for the observed data? Give a reason why the variance in the observed data might be larger than the predicted variance from the binomial distribution.

(2 – 10 pts)
Use curve() to show how the logistic curve changes as each parameter (a and b) varies from positive to negative. The logistic curve is

$$y = \frac{\exp(a + bx)}{1 + \exp(a + bx)}$$

Make two plots, one where you vary a over a number of values, and one where you vary b over a number of values. Use the option add=TRUE to plot the different curves on the same plot, with different colors. Use legend() to add a legend for the different colors.

(3 – 10 pts)

In lecture we talked about the Type II functional response, $f(R) = \frac{aR}{1+ahR}$, and gave an example for wolves feeding on caribou. Use curve() to make some plots showing how the shape of this curve varies as you vary the handling time (*h*) and the attack rate (*a*). How do these parameters differ in how they control the shape of the curve, particularly (1) when prey density (*R*) is very low and (2) when prey density is very high? If you were a hungry wolf who was hunting for low-density caribou, would you rather increase your attack rate or decrease your handling time? Make sure you plot this with a large enough range on the *x*-axis to see how the curve saturates.