**Note: read through the shiny Instructions in the Introduction folder if you haven’t already, or have forgotten how to make shiny run.**

**Breeder’s equation**

This simulator allows you to simulate a single generation of artificial selection on a phenotypic trait, and shows the predicted response. E.g., you might think asking how much you would improve the milk yield of your stock if you selectively breed from only cattle that yield > 10 gallons/day. (Note this number is made up, and may be entirely unreaslistic.)

Trait values are recentred on the population mean: this means that an 11cm long individual in a population with an average length of 10cm will have a trait value of ‘1 cm’, reflecting the fact that it is 1 cm taller than the mean.

**Input:**

-The number of individuals in your population of parents

-The heritability of the trait under selection

-The selection threshold—you will breed from individuals with trait values only above or below this value

-Choose if you’d like to breed from individual above or below the threshold value

**Output:**

The output shows three histograms; in all three cases, the x-axis is the trait value, and the y-axis is the number of individuals with that trait value, with vertical lines to show relevant parameters.

**Top plot:** Shows the distribution of trait values for the parents.

The ***blue*** vertical line shows the mean of the parents in your sample. Because it is a stochastic simulation, the sample mean of the parents may be slightly different than 0, particularly so if you choose a small number of parents.

The ***green*** box shows the parents selected to breed offspring from.

**Middle plot:** The middle plot shows the trait distribution of the selected parents. The ***green*** vertical line shows the mean of these parents.

**Bottom plot:** This is the most important, and most complicated of the plots. It shows the trait distribution in the offspring. (Note that the way R draws histograms is sometimes a little wonky.)

There are three lines—the ***blue*** vertical line shows the mean of the parents in your sample, matching the top plot.

The ***green*** vertical line shows the mean of the parents selected for breeding, matching the middle plot.

The ***red*** vertical line shows the mean of the offspring.

This plot also shows the expected and observed outcomes of the simulatons, based on the Breeders’ equation: R = h2 S.

h2: ‘heritability’, or the part of the population variation that is passed on from parents to offspring; this is set with the inputs on the left.

S: ‘the selection differential’ this is the difference between the mean of the selected parents (green line) and the overall mean of the parents (blue line). It is not directly set in the inputs, but is a consequence of setting a selection threshold.

R: ‘the response to selection’ is the difference between the parent mean (green line) and offspring mean (red line)

The observed outcome is shown in the text as ‘actual response’, as well as labelled on the plot. The expected outcome is shown in the text. These may be slightly different, again, as this is a stochastic simulation.

Answer the questions below to make sure you understand the simulation.

Press escape to end the simulation when you are done.

1. **Effect of selection threshold.** Set up a simulation heritability at 0.5 and a large number of individuals.
   1. Set the selection threshold to breed only from parents with a trait value above -3. What does this do to the selection differential and response?
   2. Increase the selection differential to breed only from those parents above the mean. What does this do to the selection differential and response?
2. **Effect of heritability.** Set up a simulation with the selection threshold at 0, and a large number of individuals.
   1. Set the heritability to 0. What does this do to the selection differential and response?
   2. Increase heritability to 0.5 and 1. What does this do to the selection differential and response?
   3. Explain this result in terms of the 3 requirements for evolution to happen.
3. **Effect of population size.** Set up a simulation with the selection threshold at 0 and heritability around 0.5. Try several small and several large values of population size. Focusing on the top plot, examine the mean trait value among the parent. The expected value for the mean is 0. Is it always exactly zero? Similarly, compare the expected and actual responses to selection in the bottom plot—are they always exactly the same?

Are the expected and actual values closer to each other when the population size is large or small? Can you explain why?