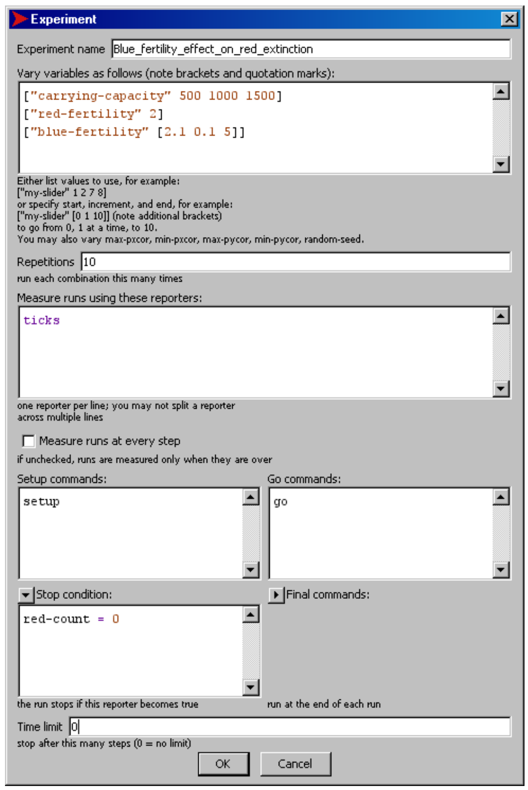
Chapter 8 Exercise Hints and Solutions

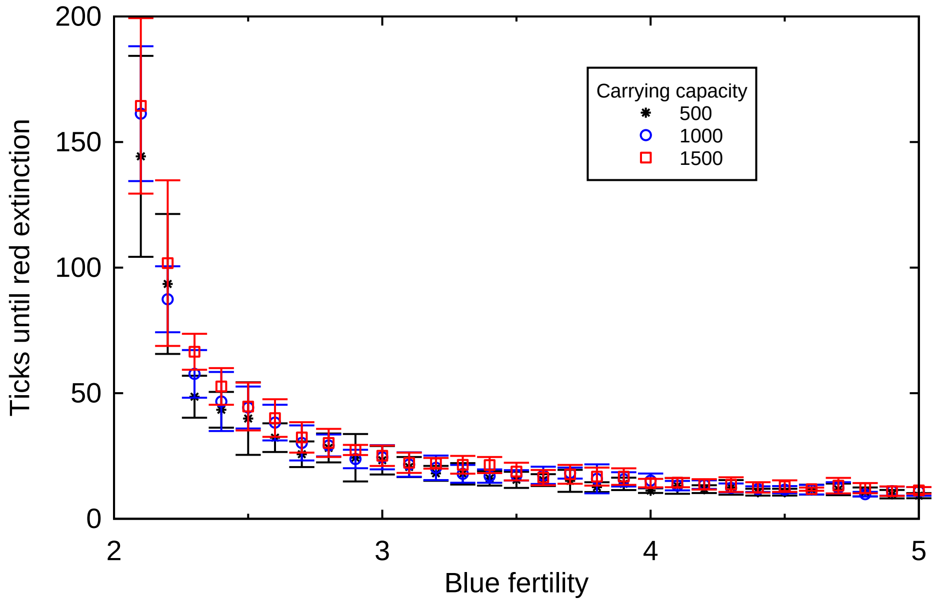
Agent-based and Individual-Based Modeling: *A Practical Introduction, 2nd Edition*

Exercise 1

Here is the BehaviorSpace experiment setup for this exercise:



The results indicate that time to red extinction is higher when carrying capacity is higher, but the difference is small compared to the variability among replicates. (This is an example of when "statistical significance" becomes a fuzzy concept with simulation models: if we run enough replicates, the differences among carrying capacity scenarios can become highly "significant" even though they are very small.)



The Excel workbook used to produce the above graph is provided with the instructor materials (`Simple Birth Rates_Ch08-Ex1 Blue_fertility_effect_on_red_extinction-table.xls`). It uses Excel's "PivotTable" tool, which is extremely powerful for analyzing BehaviorSpace experiments. It is well worth taking the time to make sure students understand how to use PivotTable. (The Calc spreadsheet software in OpenOffice/LibreOffice has a similar tool, called Pivot Table.)

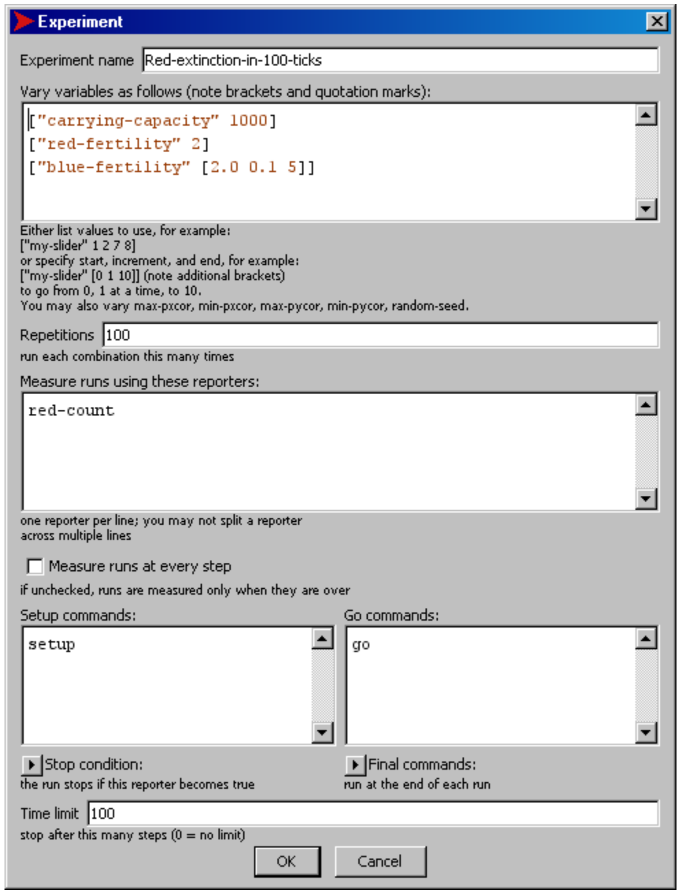
Exercise 2

The experiment design for this risk assessment is to run the model for 100 ticks, many times, and measure how many of the model runs produced red extinction. There are two changes in experiment design from the previous experiments:

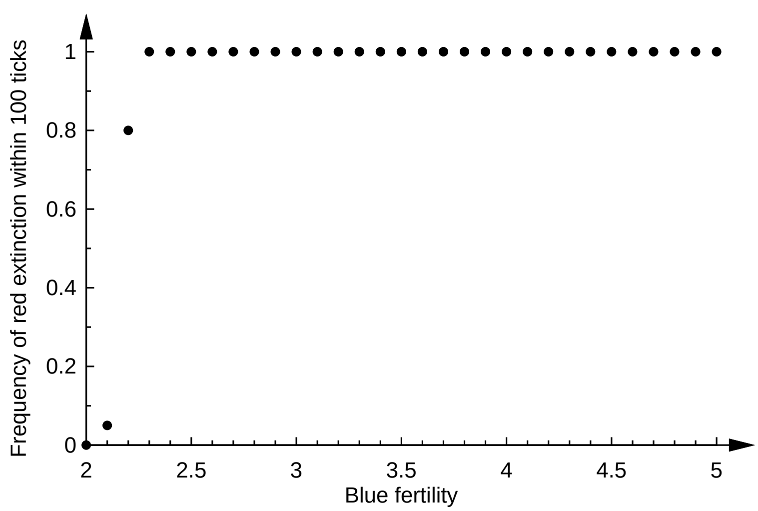
- We need to run the model for many replicates to get a good estimate of how frequently extinction occurs. (Extinction within 100 ticks is a boolean yes-no event, and when it is rare we need many replicates to get a good estimate of how probable it is.)

- We can now include experiments where blue-fertility is equal, or even less than, red-fertility. In the previous experiments, we ran the model until red turtles were extinct, which could be infinitely if red and blue fertility were equal. Now we always stop the model at 100 ticks, so we can see whether reds ever go extinct within 100 ticks even when their fertility is relatively high.

Here is one way to set up BehaviorSpace, with 100 replicates for each value of `blue-fertility` and `blue-fertility` values starting at 2.0 instead of 2.1.



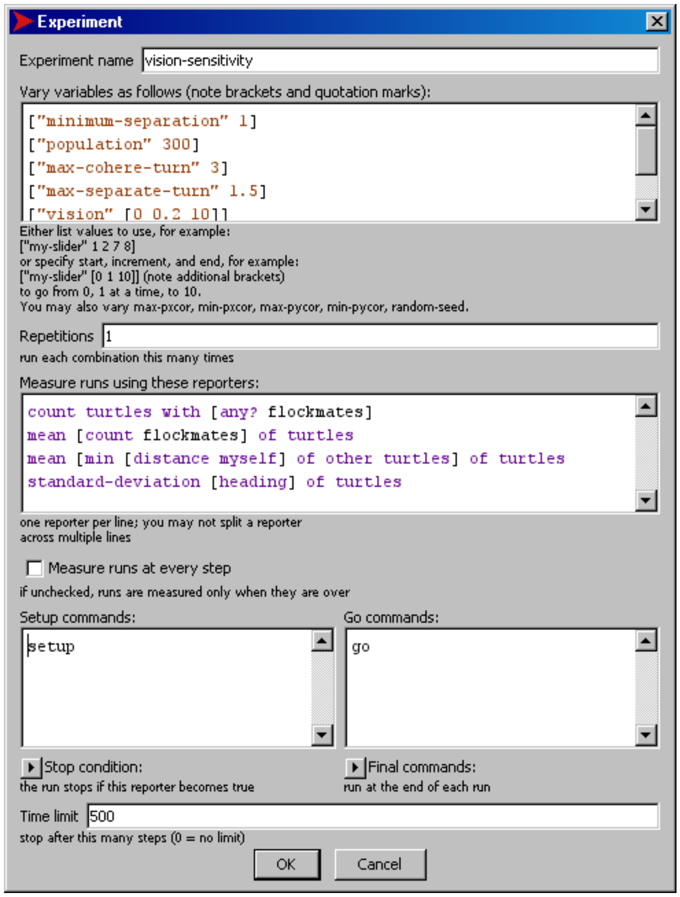
This Experiment setup simply runs the model for 100 ticks and then outputs the number of red turtles. The spreadsheet `Simple Birth Rates_Ch08-Ex2 Red-extinction-in-100-ticks-table.xls` shows how this BehaviorSpace output can be analyzed to produce a graph like this:



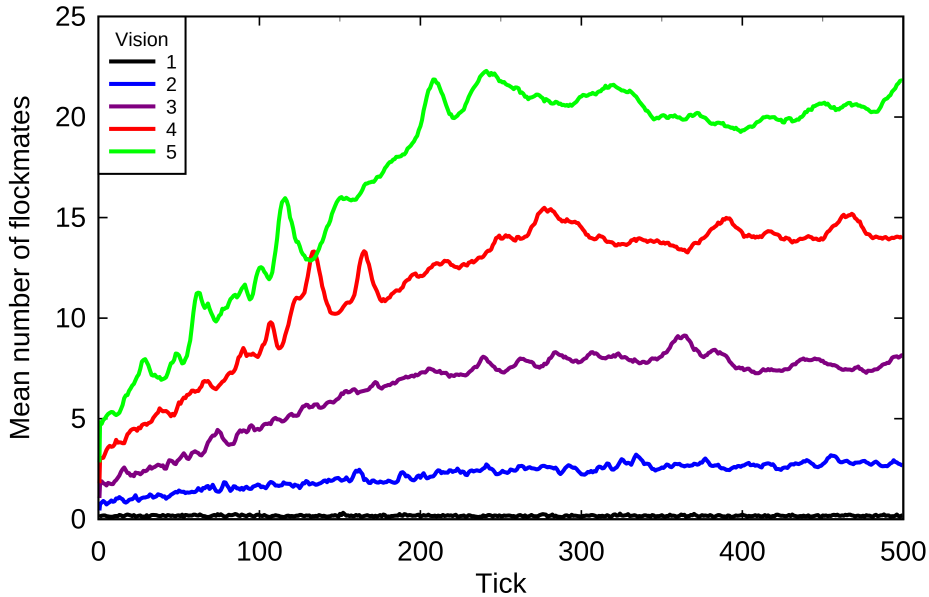
The risk of red extinction rises very rapidly as blue fertility increases from 2.0 to 2.3. Ideally, students would run a second experiment focused on that small range of `blue-fertility` values.

Exercise 3

Students should use experiments like this (do not try to do do these sensitivity experiments by varying more than one parameter at a time!):



and produce results such as these (for comparison to the top panel of Figure 8.5; only one replicate is sufficient for these experiments):



Exercise 4

The model can be modified so turtles follow the nearest six other turtles by making this change to `find-flockmates`:

```
to find-flockmates  ;; turtle procedure
 ; set flockmates other turtles in-radius vision
   set flockmates min-n-of 6 (other turtles) [distance myself]
```

The most convincing way to test that there are always six flockmates and that they do not include the turtle itself is to open a test output file and output the "who" numbers of all the flockmates, and the turtle owning them. Add these output statements to `find-flockmates`:

```
to find-flockmates  ;; turtle procedure
  file-open "FlockmateTest.csv"
 ; set flockmates other turtles in-radius vision
   set flockmates min-n-of 6 (other turtles) [distance myself]
   ask flockmates [file-type (word who ",")]
   file-print who
   file-close
end
```

Then the test file can be examined in spreadsheet or statistical software. For example, in Excel you can add this formula to column H: `=COUNTIF(A1:F1,"=G1")`. It returns a zero unless any of the values in cols. A-F (the `who` values of the flockmates) equals the value in col. G (the owning turtle's `who`).

Exercise 5

The change in turtle behavior is implemented via this change to `find-flockmates`:

```
to find-flockmates  ;; turtle procedure
 ; set flockmates other turtles in-radius vision
   set flockmates other turtles in-cone vision 90
```

The effect appears to be relatively strong, delaying and reducing the formation of dense flocks. Compare the following graph to results for Exercise 3.