8.5 PROJECTS

Project 8.1 Modeling segregation

In 1971, Thomas Schelling (who in 2005 was co-recipient of the Nobel Prize in Economics) proposed a theoretical model for how racial segregation occurs in urban areas [56]. In the *Schelling model*, as it is now called, individuals belonging to one of two groups live in houses arranged in a grid. Let's call the two groups the Plain-Belly Sneetches and the Star-Belly Sneetches [59]. Each cell in the grid contains a house that is either vacant or inhabited by a Plain-Belly or a Star-Belly. Because each cell represents an individual with its own independent attribute(s), simulations such as these are known as *agent-based simulations*. Contrast this approach with the population models in Chapter 4 in which there were no discernible individuals. Instead, we were concerned there only with aggregate sizes of populations of identical individuals.

In an instance of the Schelling model, the grid is initialized to contain some proportion of Plain-Bellies, Star-Bellies, and unoccupied cells (say 0.45, 0.45, 0.10, respectively) with their locations chosen at random. At each step, a Sneetch looks at each of its eight neighbors. (If a neighbor is off the side of the grid, wrap around to the other side.) If the fraction of a cell's neighbors that are different from itself exceeds some "tolerance threshold," the Sneetch moves to a randomly chosen unoccupied cell. Otherwise, the Sneetch stays put. For example, if the tolerance threshold is 3/8, then a Sneetch will move if more than three of its neighbors are different. We would like to answer the following question.

Question 8.1.1 *Are there particular tolerance thresholds at which the two groups always segregate themselves over time?*

Create a simulation of the Schelling model to answer this question. Visualize its behavior using the turtle graphics functions provided for the Game of Life. Experiment with different tolerance thresholds, and then answer the following questions, in addition to the one above.

Question 8.1.2 *Are there tolerance thresholds at which segregation happens only some of the time? Or does it occur all of the time for some tolerance thresholds and never for others?*

Question 8.1.3 *In the patterns you observed when answering the previous questions, was there a "tipping point" or "phase transition" in the tolerance threshold? In other words, is there a value of the tolerance threshold that satisfies the following property: if the tolerance threshold is below this value, then one thing is certain to happen and if the tolerance threshold is above this value then another thing is certain to happen?*

Question 8.1.4 *If the cells become segregated, are there "typical" patterns of segregation or is segregation different every time?*

Question 8.1.5 *The Schelling model demonstrates how a "macro" (i.e., global) property like segregation can evolve in an unpredictable way out of a sequence of entirely "micro" (i.e., local) events. (Indeed, Schelling even wrote a book titled* Micromotives and Macrobehavior *[57].) Such properties are called* emergent*. Can you think of other examples of emergent phenomena?*

Question 8.1.6 *Based on the outcome of this model, can you conclude that segregation happens because individuals are racist? Or is it possible that something else is happening?*