Exercise Hints and Solutions for Chapter 22

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

Exercise 1

The new movement trait can be implemented by replacing the procedure `find-a-spot` by a procedure like this:

```
to find-good-spot

 let good-spots patches with [(not any? turtles-here) and (is-happy? myself)]
 if any? good-spots
  [
    move-to one-of good-spots
  ]
end
```

and adding this reporter, modified from `update-turtles`:

```
to-report is-happy? [a-turtle]  ; a boolean *patch* reporter

    let num-similar-nearby count (turtles-on neighbors)
      with [color = [color] of a-turtle]
    let num-other-nearby count (turtles-on neighbors)
      with [color != [color] of a-turtle]
    let num-total-nearby num-similar-nearby + num-other-nearby
    let is-happy? num-similar-nearby >= ( %-similar-wanted * num-total-nearby
/ 100 )

    report is-happy?

end
```

(A shorter, clearer way to write this reporter is:

```
to-report is-happy? [a-turtle]  ; a boolean patch reporter

  let num-similar-nearby count (turtles-on neighbors) with
      [color = [color] of a-turtle]
  let num-nearby count turtles-on neighbors
  ifelse num-nearby > 0
  [ report (num-similar-nearby / num-nearby) >= (%-similar-wanted / 100) ]
  [ report true ] ; assume turtle is happy if no neighbors
end
```

)

This change is implemented in the Instructor Materials file `Segregation-Ex22-1_2ndEd.nlogo`. Some differences from the standard Segregation model (but with the "density" slider set to 80%) are:

- The system reaches its final state (all households are happy, or the percent of unhappy households stops changing) in far fewer ticks.
- The number of households moving each tick appears to be lower.
- When the value of *%-similar-wanted* is too high for the households to all be happy, the unhappy ones do not continue moving; instead, no households move even when some are unhappy.

These differences appear to result from one key process difference: now, when households move, they are unlikely to make their new neighbors unhappy so that those neighbors then move. In the original Segregation model, random movement of households often caused movers to destabilize the neighborhood they move to, so one movement triggers more.

Some other differences are:

- The number of ticks until movement stops no longer increases consistently as *%-similar-wanted* increases.
- The sharp tipping point between two states (all happy vs. no decrease in unhappiness) happens at *%-similar-wanted* equal to 72%, with few or no model runs producing segregation at higher values.
- When *%-similar-wanted* is too high for households to all become happy, the model no longer runs forever with no decrease in unhappiness. Instead, there is a decrease in unhappiness within 1-2 ticks and then no further change. This decrease in unhappiness becomes less as *%-similar-wanted* increases. When *%-similar-wanted* is in the range of 75-80%, for example, final unhappiness is typically > 80%.
- The tipping point at which results switch between the two states varies more with the density of households. When the density of households is lower, all households are more likely to be happy at higher values of *%-similar-wanted*.

Because the final value of *percent-unhappy* varies now (whereas in the original model it was always either 0 or close to its initial value) it could be a useful new currency for model analysis.

Exercise 2

One way to add streets to the Segregation model is to ask patches with X and Y coordinates that are whole multiples of the street spacing (here, 10 patches) to turn a different color, and not allow households on patches of that color. An example is provided in the file `Segregation-Ex22-2_Streets_2ndEd.nlogo`. Note that in this code: (a) the street spacing is controlled by a slider instead of being fixed, (b) changing the World settings for "Location of origin" to "Corner" causes streets to coincide with edges of the World, (c) in the `setup` procedure, the statement that sprouts turtles is modified to exclude patches that are streets, and (d) the `find-new-spot` procedure is modified to exclude street patches.

When streets are added to the Segregation model, its behavior does not change drastically. With streets every 10 patches, the tipping point between complete and no decrease in unhappiness remains at *%-similar-wanted* = 75%.

The model changes substantially if you make the streets closer together. The tipping point increases as the size of the "blocks" (squares of patches isolated by streets) decreases. For example, with streets every 6 patches (and household density of 80%) the tipping point is at about *%-similar-wanted* = 80%. With streets every 8 patches the model can become completely segregated (after a long time) at *%-similar-wanted* = 76%.

The process causing these differences appears to be that once a "block" of patches is completely segregated, it is isolated from the rest of the model and cannot become destabilized by households moving nearby.

This process actually makes it possible for the model to reach complete segregation (unhappiness = 0%) even when *%-similar-wanted* is as high as 100%. Whenever a block becomes completely segregated, even by chance, it no longer changes; over long simulations all the blocks can become segregated. When blocks are very small (e.g., 3 × 3 patches) this happens very quickly.