Survival of the Fittest (Continued)

Last week you created a model in which hawks and doves interacted with each other in a predator prey relationship. Now its time to convert that model into a survival of the fittest-model where doves and hawks can evolve. Open your model from last week and save a copy called "lastname_firstname_week_7.nlogo for the homework. Answer homework questions by either writing the procedures or putting your answers in the information tab, as appropriate.

Homework

1. Let your doves evolve. There are a total of nine variables influencing the movement of the doves, so your genetic code will be made up of the values you assign to each of these variables. For each of the dove-related sliders in your previous model (except population) make a `doves-own` variable. When you first create the doves assign each of these variables a random number (use random-float) between 0 and what you judge to be a suitable upper limit. Caution: to get realistic evolution make sure the upper limit for the two dove speeds sums to a number less than the the hawk's hunt-speed. If you don't you may create super doves by hand rather than allowing them to evolve. On another note, in this lab you do not need to create a genome-list as you did in the week 5 lab, because we will be mutating the genetic code in a slightly different way this time.
2. Create sliders for the mutation rates of each of the variables in question 1, choosing a range of values so that moderate, yet significant change in behavior can occur. In the experimental phase of the lab you will be adjusting these parameters to see how mutation rates influence evolution.
3. In your birth procedure add a line asking newly hatched turtles to mutate, and then write a mutate procedure. This mutate procedure will be slightly different from the one you wrote you did in the week 5 lab. Instead of only selecting one gene to mutate you will mutate all the genes in turn by adding a mutation factor. The mutation factor will be either plus or minus the mutation rate. You will need to write a separate line of code for each variable in the genetic code.
4. Create monitors to keep track each variable in the genetic code. The monitors should show the average values from all the doves.
5. So that you can have a measure of the improved fitness of your doves create two new globals variables called deaths and ticks. These variables should start at 0. Deaths should increase by one every time a turtle is killed by a hawk and ticks should increase by 1 every time step. Now plot a graph of deaths per tick.
6. Test the model under general conditions. Allow it to run for a while – there are several changes that happen. First unfit birds are weeded out quite quickly. Then some of the gene's of the surviving birds change slowly over time. What genes change the most? Explain why? If you run the program a number of different times, with the same settings, you should be able to see species with slightly different behaviors surviving. Occasionally two species with different behaviors persist for some time together. They may have approximately equal survival rates, but for different reasons. Eventually genetic drift will eliminate one of these species. Describe the different survival strategies you observe.
7. Now lets experiment with mutation rates. Set mutation rates for all dove *speeds* to zero. Now the speeds will not change. Which genes change the most now? Does the death rate decrease? Does it go down as low as in question 6?. You should notice that some of the gene's seem to keep increasing in value, yet the the survival rate of the doves doesn't improve. Explain what is happening?
8. Repeat the analysis you did in each of the previous questions, but increase the number of

hawks significantly. This should accelerate the selection pressure significantly. Does it alter the behavior and genetic make-up of successful doves?

9. Repeat the analysis now by setting all mutation rates high. Does this have an affect on the overall fitness? Make quantitative comparisons. How about when mutation rates are low?
10. Replace the flocking command in `go`, with a simple `wiggle` at `normal-speed` command. Return mutation rates to the values in 6. Allow the system to evolve. What do you notice about the survival rates of the doves. Is flocking a good survival strategy? Do you think your answer would be different if you changed the number of hawks to a lower number?
11. Now I would like you to enhance your model in one of the two following ways – you pick:
    (a) It is not really fair that doves can evolve but hawks can't. Lets let Hawks evolve too. In order to evolve we have to let them die. Give hawks an initial energy, a metabolism, and an increase in energy from eating doves. Hawks die if their energy reaches zero. (you could also use this variable to control the resting time. For example, perhaps they gain 20 units of energy when they eat a dove and start hunting for another one when their energy has dropped to 10). If a hawk dies, let another hawk give birth to a new but slightly mutated hawk. You will need to write a hawk-mutate procedure and define suitable gene variables for the hawks. Have fun. Do you observe any arms-race type behavior in the evolution of hawks and doves?
    (b) To allow for two species of doves to evolve you could create a larger green area on the screen representing a forest. Allow the color of the doves to be a genetic variable, and also allow doves to optionally head towards or away from green patches if they can see them. To apply selection pressure make it difficult for hawks to see doves with shades of green who are on green trees. Does this enhancement lead to speciation, or just a bunch of green doves who like to sit on trees?
12. Before submitting your NetLogo program write comments for all your procedures explaining what each “non obvious” line does.