Project Proposal: Modeling Natural Selection in NetLogo

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1 Abstract

I want to model natural selection of a single arbitrary species by giving them different traits and modeling their evolution across generations. I'm basing my work in Primer's YouTube video "Simulating Natural Selection" [1], where a number of creatures named "blobs" must compete to get food and survive. If a blob gets one unit of food, It will survive another day, if it collects two units, it will also reproduce for the next generation. Upon reproduction, blobs have a small chance of increasing a special trait such as speed, size or awareness, which will help them to collect food easier at a cost of distance they can travel. I will use a similar model to the one described, but that's something to decide after doing the needed research.

For initial research, I will use articles for a better understanding of the math behind modeling natural selection [2], and computation of genetics [3] across generations, as well as a book in game theory and natural selection [4]. After getting a full understanding on how to create the model and how different traits will work, I expect to play with the parameters to model different scenarios to come up with results explaining the benefits of each trait and how the generations adapt after a long period of time. The result of running various simulations will produce graphs I will compare and write about in my Junior Independent Study.

The software environment I plan to use to create a similar model using the programming language NetLogo, made for 2D simulations. There are many examples in the NetLogo website about species collecting an item that will make them evolve, which I will use to learn the programming language. NetLogo can produce it's own graphs, which I will either use for my final repor, or extrapolate the data to create plots in Wolfram Mathematica. If I decide to compare more that two traits, I'll consider producing 3D graphs or 2D graphs with color coding to express a third trait. If I do construct 3D graphs, I will include color coding for a characteristic of the simulation that's not a trait, such as average population number or average dying age of the creatures.

Some traits I already thought of experimenting with involve cooperation or some sort on interaction between the creatures. The traits described before are known as "selfish traits" since they only aim to benefit the creature as an individual. If I introduce interaction traits, I could maybe research on selfish vs. cooperative traits, to compare individuality and social cooperation. And aside from cooperation traits, other interactions they could have could be selfish as in stealing food or reduce other individuals from using their full potential of their traits. But that's a decision I will make after I do the research and determine which will be the most interesting for me to investigate.

2 Software Outline

I'm basing my design in NetLogo's library examples in their website. This can be seen in Fig. 1.

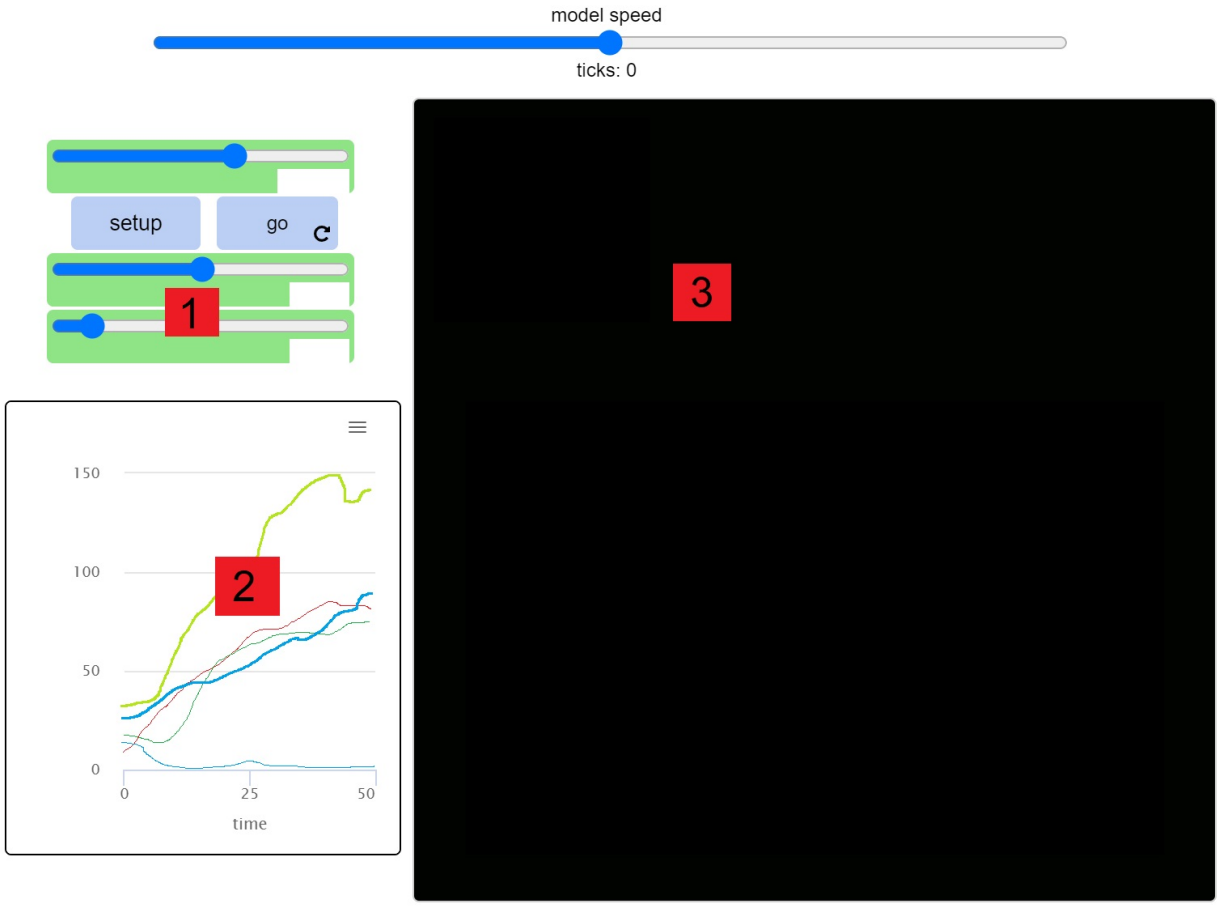

Figure 1: Software Design, where (1) is the control parameters for the simulation, (2) is the output graphs of various parameters over time (population number, average trait values, age...), and (3) is the simulation output, where the species and food items can be seen in real time.

References

[1] Primer, "Simulating natural selection," 2018. Accessed on 24 February 2022, `https://www.youtube.com/watch?v=0ZGbIKd0XrM`.

[2] A. Kleinman, "The basic science and mathematics of random mutation and natural selection," *Statistics in Medicine*, vol. 33, no. 29, pp. 5074–5080, 2014.

[3] B. Glymour, "Wayward modeling: population genetics and natural selection," *Philosophy of Science*, vol. 73, no. 4, pp. 369–389, 2006.

[4] T. L. Vincent and J. S. Brown, *Evolutionary game theory, natural selection, and Darwinian dynamics*. Cambridge University Press, 2005.