Quick Reference Guide for Predator-Prey Interactions Simulator

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Overview

Our simulator teaches students about animal herding in the presence of a predator—an example of a complex system undergoing time evolution. Users can choose from two different herding models described in our *European Journal of Physics* manuscript submission. They are called the Local Crowded Horizon (LCH) and the Voronoi (V) models. The user interface (UI) features buttons and slide-bars that allow for the adjustment of several simulation parameters, including noise, and it displays a herding animation as well as statistical results.

We offer two versions of our simulator: (1) original MATLAB code that requires MATLAB to be installed on your computer, (2) a standalone, executable file that can run on your computer even if you do not have MATLAB installed.

Software Installation

(1) All of our files are located at https://github.com/UST-ComplexSystems/Selfish-Herd. Download the files by clicking the "Clone or download button" followed by "Download ZIP." Save the Selfish-Herd-master.zip folder to your computer.

(2) Right-click on that zip folder and select Extract All. In the subsequent pop-up window, choose a location for the extraction folder named Selfish-Herd-master.

(3) To use the original source code for the Predator-Prey Interactions Simulator, you need to have MATLAB installed on your computer. Open the file named Predator_Prey_UI.m in MATLAB and press the Run button to launch the UI. *Skip steps (4) – (6) below.*

(4) If you wish to use our standalone, executable file that does not require MATLAB, double click the file titled Predator_Prey_UI_Installer.exe. You might see a blue window titled "Windows protected your PC." If so, click on More Info and then Run Anyway. Also, you might need administrative privileges on your computer, and you might have to wait a few moments before anything pops up on your screen after clicking.

(5) When the Predator_Prey_UI Installer window pops up, follow the instructions. Wait for the software to install. The installer will detect whether MATLAB Runtime is already on your computer. If not, it will retrieve Runtime from https://www.mathworks.com/. This process might take several minutes. (If you encounter installation problems, consider uninstalling MATLAB Runtime from your computer and reinstalling our software in order to obtain the appropriate version of Runtime.)

(6) If you added a shortcut to the desktop, then double click it to run the UI. If you did not add a shortcut to the desktop, then go to the Predator_Prey_UI folder wherever you saved it. Then go the application subfolder and double click on the Predator_Prey_UI.exe file to run the UI.

(Note: This process works smoothly on almost all computers we have tried, but we have seen a blank window pop up when running the UI for the first time on one of our computers. If you see that, you might have to double click on the Predator_Prey_UI.exe file a second time to make it work.)

The UI has buttons on the upper-left of the screen that allow you to change the font size to best fit your display.

Description of the User Interface

Domain of Danger Simulation

Domain of Danger (DOD) simulations give a measure of the improvement in predation risk as the herd coalesces. The DOD is the area closer to each individual than to any other, and they are collectively shown for the herd as polygons (known as a Voronoi tessellation) in the Animation window. DOD simulations compare the area of the polygon initially surrounding each animal to the corresponding area after the selected number of time steps is completed. After each run, the Statistics window displays the percent of the herd that improved (i.e., decreased) their DOD. A full histogram is displayed after all runs are complete. Also reported are the average and standard deviation of the histogram results.

The Domain of Danger simulation under Herd Settings is for a herd that follows one of these movement rules listed under 1st Herd Movement Rules: LCH, LCH + Noise, Voronoi, Voronoi + Noise. In this simulation the slide bar for Second Herd # of Members is disabled, as are the buttons for 2nd Herd Movement Rules. Users may choose either a Random Herd or a Reference Herd. The latter starts 100 herd animals at the same initial positions every time it is used.

If either LCH or Voronoi are selected (without noise), then the Noise Weight slide bar under Simulation Settings is disabled. If noise is included, then a Noise Weight from 0 to 5 can be chosen using the slide bar or simply by typing a value in the appropriate text box. A noise weighting of one means that its magnitude is equal to that of the LCH or V movement rule, whereas a noise weighting of two means it is twice as large, etc.

Mixed Herd Simulation

Mixed Herd simulations measure predation risk through a head-to-head competition between animals that follow either of two chosen movement rules. When the selected number of timesteps is reached, a predator is created off-screen in a random direction. After that point, the # of Timesteps indicator displays two numbers: the first is the number of timesteps for

which the herd animals were able to interact before the predator appeared, and the second is the extra number of timesteps required for the predator to overtake and "kill" its prey (a single herd member).

The Mixed Herd simulation allows users to select two movement rules for the herd. If the Reference Herd is selected, exactly 50 animals will follow each movement rule, and will always start at the same initial positions. The Random Herd setting allows users to choose the number of members in each herd, with random initial positions in each run. In the Mixed Herd simulation, the Animation window shows the motion of each herd member, using the symbol "**x**" for individuals following 1st Herd Movement Rules and the symbol "**+**" for those following 2nd Herd Movement Rules. The predator is indicated by the symbol "✦". The Statistics window reports the Number of Dead Prey in Herd 1 and Herd 2 after each run.

Saving Files

To save data for a run without choosing your own file name, click Run And Save. A file name that includes the simulation type, the date, and the time will automatically be chosen for you. Here is an example: DOD_LCH_04-22-18_Date_09-53-07_Time (using the format MM-DD-YY for the date and HH-MM-SS for time). The file will be saved to the folder of your choosing.

To save data using your own file name, click beneath the Save File Name line and enter a name. Again, a prompt will ask you where to save the file.

Otherwise, the UI can be run without saving.