**ABM – Week 5 – Seminar – LVL1**

**Purpose**

This task will allow you to learn how to use BehaviorSpace to systematically investigate model behaviour.

**Model**

This task uses the Fireflies model (Wilensky, 1997), from the NetLogo Models Library. From the Info tab of the model:

“This model demonstrates a population of fireflies which synchronize their flashing using only the interactions between the individual fireflies. It is a good example of how a distributed system (i.e. a system with many interacting elements, but no ‘leader’) can coordinate itself without any central coordinator.”

Read the “How it works” and “How to use it” sections of the Info tab to get an idea of the model and its variables.

Wilensky, U. (1997). NetLogo Fireflies model. <http://ccl.northwestern.edu/netlogo/models/Fireflies>. Center for Connected Learning and Computer-Based Modeling, Northwestern University, Evanston, IL.

**Task**

* Save the model under a new filename to avoid overwriting the original.
* Edit the model code so that it records how long it takes for the fireflies to synchronise their flashing (if they ever do).
* Conduct experiments using BehaviorSpace to systematically examine how the parameters cycle-length and flash-length affect the time to synchronisation. (You should carefully consider the range over which each parameter will be investigated, and choose an appropriate number of replicates for each set of parameters.)
* Use Excel (or similar) to present the results of these experiments in a two-way table, colour the cells by the time to synchronisation, and provide a colour bar to aid interpretation. Present a second table to communicate the variation in the time to synchronisation across the replicates, for each set of parameters.
* Run the model again for the pair of parameters corresponding to the shortest time to synchronisation. Export the data from the plot in the interface and recreate the plot in Excel (or similar) with improved presentation.

**Extensions**

Extend your investigation to consider other parameters.

**Step-By-Step Guide**

1. Save the model under a new filename.

Recording the time to synchronisation

1. Add a “globals” block to the program and introduce two new global variables: the first variable will record whether the fireflies have synchronised yet; the second will record the time when they synchronise. You should give these variables appropriate names.

*Useful primitives: globals*

1. In the setup procedure, set these variables to equal False and –1 respectively.  
   *Useful primitives: set*

*Note: –1 is a placeholder value for the synchronisation time. It is deliberately an impossible value to clearly indicate that the true value has not yet been found.*

1. Create a new procedure to monitor whether the fireflies have synchronised. This procedure should be empty for now.

*Useful primitives: to, end*

1. In the new procedure, create a temporary variable, flash-number, which counts the number of fireflies that are currently flashing.

*Useful primitives: let, count, turtles, with, color, yellow*

1. On the next line of the procedure, use an if statement to reset your two global variables respectively to True and to the current time, if flash-number is equal to the total number of fireflies.

*Useful primitives: if, set, ticks*

*Hint: Check the Interface to find the name of the variable for the number of turtles.*

1. Introduce a new line to the “go” procedure, which calls your new procedure only if the fireflies have not yet synchronised.

*Useful primitives: if*

*Hint: The line needs to check whether your first global variable is True or False.*

You can now add monitors to the Interface to track the values of your new variables. If the code is working correctly, they should display False and –1 until the fireflies have all synchronised; then they should display True and the appropriate tick number.

Running BehaviorSpace

1. Select BehaviorSpace from the Tools menu and create a new experiment.
2. In the first box, specify the ranges of values of flash-length and cycle-length that you want to examine. There are many ranges that you could choose from, but try the values 1, 2, …, 5 for flash-length and 10, 11, … 14 for cycle-length.  
   *Hint: See the online guide to BehaviorSpace to check how to specify these values:*

<https://ccl.northwestern.edu/netlogo/docs/behaviorspace.html>

1. Set the number of Repetitions equal to 5, to indicate that you want to run the model 5 times for each distinct set of parameters (i.e. 5 replicates per parameter set)
2. Enter your second new global variable as the reporter for measuring each run.
3. Uncheck “Measure runs at every step”, since you are only interested in the overall time taken for the fireflies to synchronise.
4. Add a stop condition, when your first new global variable is True, since there is no need to continue a run once the fireflies have synchronised.
5. Set the time limit to an appropriate value. For these experiments, 2000 should be reasonable, but in general you should observe some model runs to determine this value for yourself.  
   *Note: A time limit is necessary to cut off simulations in which the fireflies never synchronise, or in which they would take too long to synchronise.*
6. Select OK to save your experiment, then Run it. Turn off all updates while it is running to maximise speed.

When the experiment is complete, you can inspect the table of saved results in Excel. Return to the task above to complete the remaining sections on presenting the results.

*Hint: To export the data for a NetLogo plot, control click and select Export…*