Applied Category Theory in an Artificial Life Simulation

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This simulation follows "The Greek Miracle: An Artificial Life Simulation of the Effects of Literacy on the Dynamics of Communication." by Andrew Douglas Digh. This simulation only treats vocal communication among a variable population of artificial organisms. Each organism is given a number from one up to the number of organisms. All organisms are placed in one dictionary keyed by organism number

Each organism is itself a dictionary containing a set of integer variables representing various biological features. In this program there are three dictionary entries: hear, think, say. The organisms communicate with each other according to a connection matrix that is a square matrix representing the Cartesian product of the one dimensional array {1,2,...number of organisms} with itself. A one in the connection matrix represents a connection between two organisms, a zero indicates no connection. No organism connects to itself. Notice that the square structure of the connection table creates upper and lower triangular echelons so that each pair of (row,column) in the Cartesian product is represented twice assuming order doesn't matter. The exception is the diagonal of the square where each organism is paired with itself. The program simulates communication within the organism population until a cycle occurs or the number of iterations surpasses a maximum iteration value. After the simulation run completes, the transient length and the cycle length are recorded. The transient length is the number of iterations before the state of all organism together occurs that is eventually repeated to determine a cycle. The cycle length is the difference between the iteration numbers of the state that repeats to determine a cycle.

The set O is set of tested organism populations.
O = {5,10,15...50}

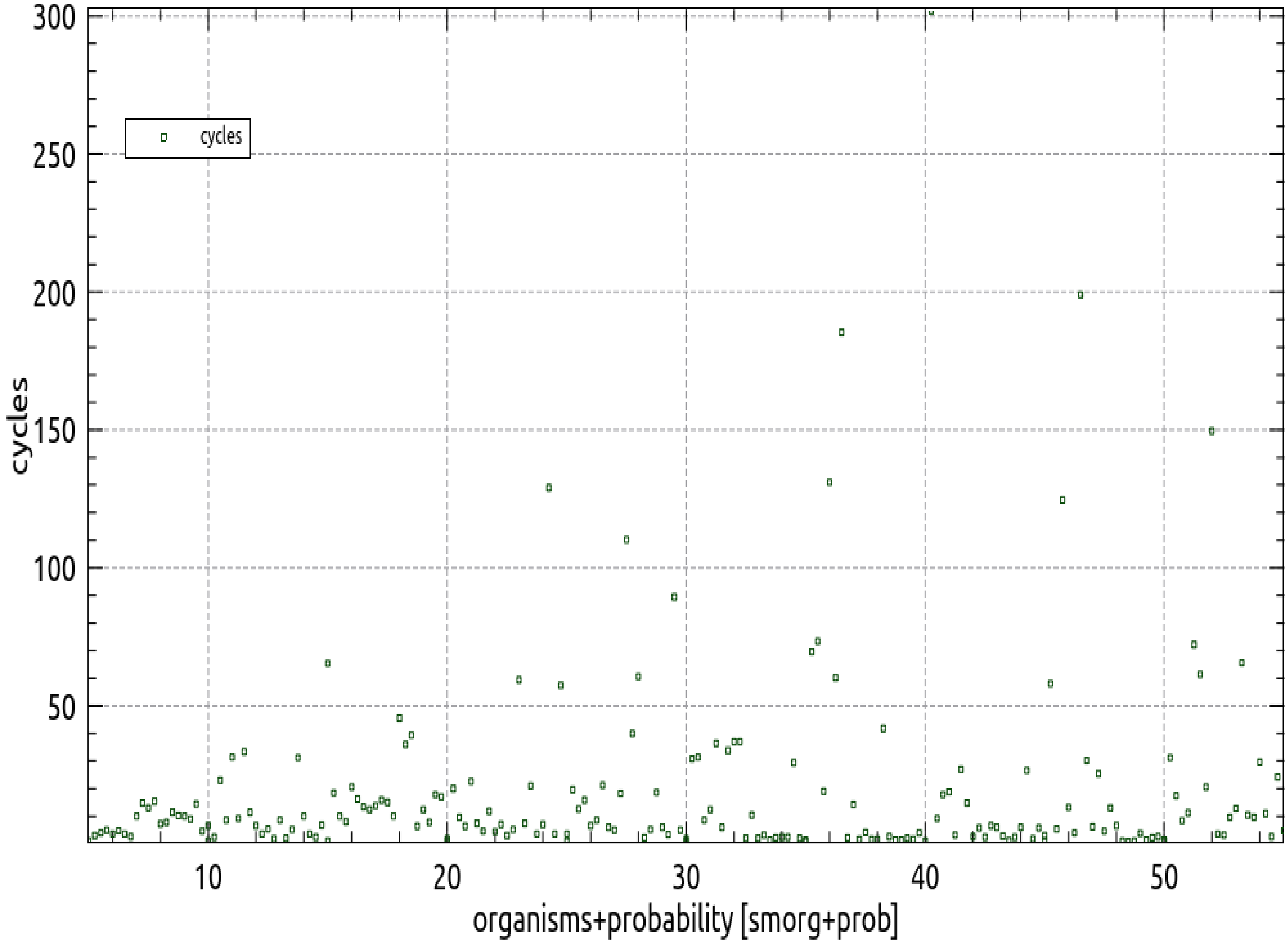
The set P is the set of connection probabilities tested.
P = {0., .05, .10, .15...1}

$$\begin{tikzcd}
& O \times P \arrow[dl, "i1"'] \arrow[dr, "i2"] & \\
O & & P \\
& A \arrow[ul, "f"] \arrow[ur, "g"'] \arrow[uu, dashed] &
\end{tikzcd}$$

This diagram commutes. The dotted arrow is the induced function <f,g>. It might be best rendered graphically in three dimensions. On the following two pages are two dimensional representations obtained by creating a partition for the x-axis by adding the probability domain to each population step, e.g. [5.0, 5.05, 5.10 ...10.0) in equidistant intervals between the first two population sizes {5,10}.

Notice in the graphs on the next two pages that the transient lengths tend to be about twice as long as cycle lengths for a given point on the x-axis partitions. In the higher population sizes, this is more markedly true, more than twice as long. And generally along the x-axis partition, the higher the connection probability, the more transient length exceeds cycle length. There are many variables, both random and deterministic, that affect this outcome.

Cycle Length vs. an x-axis interpolated by a probabilty domain [0, .05, .10 ...1) between Organism population starting with 5 at the origin.



Transient Length vs. an x-axis interpolated by a probabilty domain [0, .05, .10 ...1) between Organism population starting with 5 at the origin.