Temple CST 2100 Modeling & Simulation in Science and Technology Spring 2016

Problem Set 5

(Out Tue 03/08/2016, Due Tue 03/15/2016)

Problem 5

(a) Modify the Matlab files `temple_abm_population_predator_prey.m` from the course website `http://math.temple.edu/~seibold/teaching/2016_2100/` into a simulation of an iron age battlefield, as follows:

(i) Agents represent warriors. The two species represent two armies. One army starts in $(x, y) \in [0, 1] \times [0, 10]$. The other starts in $(x, y) \in [9, 10] \times [0, 10]$. Place 100 agents on each side initially.

(ii) There is no reproduction of agents. Instead, in each step, one new warrior is spawned at a random position in the domains given in (i).

(iii) The probability of death of a warrior during a simulation step is $p_{\text{death}} = \min\{0.001m^2, 1\}$, where m is the number of warriors of the opposing army in the same square.

(iv) Warriors starting on the left have a bias to move to the right, and vice versa. This is modeled as follows. In each step, the direction angle d is a warrior is changed to $0.99d + 0.01d_0$, where $d_0 = 0$ for warriors starting on the left, and $d_0 = \pi$ for warriors starting on the right.

(v) For now, let the magnitude of angle change for each army be 0.1, and the speeds of warriors from either army be 0.02. That means that the battle is symmetric, both in terms of geometric setup and in terms of properties of the warriors/armies.

Run the code multiple times, and describe and explain the outcome of the simulation. Submit (i.e., email to the course instructor and TA) your program under the filename `yourfamilyname_problem5a.m`

(b) Now change the speed of warriors of one army to 0.01, i.e., make the warriors move slower. Run the simulation, explain the difference in outcome, and explain why this happens.

(c) Change the probability of death to $p_{\text{death}} = \min\{0.01m, 1\}$, and run your code with both warrior speeds equal to 0.02 (case (a)), as well as with warrior speeds from case (b). Describe and explain the simulation results.

(d) Change the probability of death to $p_{\text{death}} = \min\{0.1\sqrt{m}, 1\}$, and run your code with both warrior speeds equal to 0.02 (case (a)), as well as with warrior speeds from case (b). Describe and explain the simulation results.

(e) Argue which real situations the three different laws of death (in (a) vs. (c) vs. (d)) could model in terms of agent interactions.

(f) The previous models have interactions between agents only when they are close to each other (in the same square), thus modeling melee combat. Augment the model by adding the presence of archers, who can hit rival warriors from afar. Explain (based on simulation results) how the presence of archers can change the battle outcome. Submit your program under the filename `yourfamilyname_problem5f.m`