Lab exploration 3: Evolutionary systems   Math 309   Fall 2016
Deadline: 12N Friday 7 October
Late deadline: 12N Friday 14 October

- Conduct experiments as indicated.
- **Journal entry.** Respond to each of the "journal queries." Using *concise and clear sentences*, incorporate data, symbols, and illustrations into your text. Have an audience in mind. Focus on *developing* an explanation or argument that stems from your simulations.

  Submit 300-400 words 2-3 pages double-spaced in **hard copy**.
- **Recommended.** Work in groups of 2 or 3. Submit one journal entry for the group.
- **Suggestion.** Before running the simulations, read the "What is it?" and "How it works" sections under the Info tab.

Model: PD Basic Evolutionary. (Location: Models Library/Social Science/(unverified)/Prisoner's Dilemma.) The agents in this model are the patches that fill the screen. An agent A interacts with its eight neighbors (the edges wrap around) by playing PD simultaneously with each of them. For the next round of play, A adopts the strategy of the player who achieves the highest total score. (A strategy is a set of eight choices to cooperate/defect with one's neighbors.) If A defected in the previous round, a defection-award is applied to its score. If the award is greater than 1, the agent is rewarded for defecting and if it's less than 1, the agent is punished. The simulation allows you to set the initial number of cooperating agents—randomly distributed—as well as the defection-award.

3.1 Journal query.

Set defection-award = 1.00 and look for a threshold value C of initial-cooperation where for values less than C, cooperation disappears and for values greater than C, cooperation dominates. What mechanism might lead to this difference in the emergent behavior?

3.2 Journal query.

How does the threshold value change if the defection-award is adjusted either up or down? Briefly compare the behavior here to that of sensitivity to initial conditions in dynamical systems theory.

Model: Segregation. (Location: Models Library/Social Science.) This model simulates interactions among residents of a region based on considerations of *homophily*—the tendency for an agent A to be in the company of those who are similar to A in some way. The relevant trait might be education level, race, ethnicity, income/wealth level.

Each colored patch represents an agent of a particular type; red/green indicates the homophilic quality and the location represents where the agent resides. Starting in a randomized state, the system evolves by successive interactions among an agent and its eight neighbors. If those neighbors satisfy a condition (greater than %-similar-wanted), the agent is considered "happy" and doesn't move. If the condition isn't met, the agent is "unhappy" and, if it can, moves to a location where it's happy. (If there's more than one such location, it's not clear how the agent selects one to which to move. Maybe the closest?)

3.3 Journal query.

Begin with %-similar-wanted at 100%. What do you expect to happen in this case? Does the qualitative behavior depend on the density of the residences?

3.4 Journal query.

By decreasing the value of %-similar-wanted, find a threshold value where the qualitative behavior changes. (Set density = 90.) What does the new output look like? How do you explain the change in outcome? After arriving at a mostly stable process, is there persistent movement around the edges of the stable regions? How can you produce stability at the edges?

3.5 Journal query.

Set %-similar-wanted = 0. What should happen? Does it? Gradually increase %-similar-wanted. How do the outcomes vary? At what point does segregating behavior become clearly evident? Does the "segregation threshold" depend on density?

Model: Wolf Sheep Predation. (Location: Models Library/Biology.)

3.6 Journal query.

Using the default settings with grass? = On, run the model for around 1000 time steps. Note the cyclical behavior that emerges. Briefly explain why the system behaves this way.

3.7 Journal query.

Now adjust the initial wolf population and leave other parameters as they are. Can you get the wolf population to vanish by *increasing* the initial population? By *decreasing* the initial number (not to 0 of course)? Explain the outcomes of the simulations.

3.8 Journal query.

Suppose a genetic mutation allows the wolves to derive more benefit from their food (captured by wolf-gain-from-food). Is this necessarily beneficial to the wolf population?

3.9 Journal query.

In a paragraph or two compare the three models, especially with respect to ways in which they involve evolutionary processes.