Workshop #8, cellular-automata, outline for TF, not students
APM 115: mathematical modeling

cellular automata (CA) of a predator-prey (rabbit-wolf) model

- Give the Matlab program simulating the Lotka-Volterra equations (ODEs) to the students, have them run it and observe the oscillations.
- Give them next the CA model and Matlab code that corresponds to the above equations, and adds the spatial dimensions. Before giving them the code, remove the parts that calculate the total number of wolfs and rabbits as function of time and remove the part that simulates random motion of rabbits and wolves.
- The model considers only the four near neighbors of a given cell, not including diagonal cells. Have the student come up with, or justify, the following CA rules as an attempt to reproduce the Lotka-Volterra dynamics. In particular, which rule corresponds to which term in which equation and why?
  - An empty cell with rabbit neighbor(s) turns into a rabbit with a probability $a$.
  - A rabbit with wolf neighbor(s) has three possible outcomes: (1) empty (rabbit eaten…, probability $b$); (2) rabbit eaten and wolf replaces it (wolf reproduced, probability $c$) and (3) nothing (probability $1-b-c$).
  - A wolf cell has a probability $d$ to turn into an empty cell (predator death).
  - The model assumes a “double periodic” domain.
- Have the students run the CA code for these rules. The model uses for loops and if statements for simplicity (rather than the more efficient manipulation of logical arrays).
- Have the students add the calculation of, and plot, the global sum of predator and prey in the CA model as function of iteration number (equivalent to time). Can you adjust the various specified probabilities of the CA model to obtain a similar result to the ODE models?
- Have the students implement random motion of rabbits and wolves: After each step, move each rabbit and wolf to a randomly selected nearby location, if that location is empty. If not empty, leave rabbit or wolf unmoved.