Final Exam—Due Thursday, March 13 at 11:30 AM

Instructions: Complete the following tasks. Copy and paste your code and analysis into a DOC/PDF/ODT document (like a lab report). Also upload a script and/or functions files with your code. You will submit this work online through the CROPS assignment page. For the plots, you must use the `xlabel`, `ylabel`, and `title` parameters on every plot to receive full credit.

1 Setting

The universe of **Conway's Game of Life** is an infinite two-dimensional orthogonal grid of square cells, each of which is in one of two possible states: *alive* or *dead*. Every cell interacts with its eight *neighbors*, which are the cells that are horizontally, vertically, or diagonally adjacent. At each step in time, the following transitions occur:

1. Any live cell with fewer than 2 live neighbors dies, as if caused by under-population.
2. Any live cell with 2 or 3 neighbors lives on to the next generation.
3. Any live cell with more than 3 live neighbors dies, as if by overcrowding.
4. Any dead cell with exactly 3 live neighbors becomes a live cell, as if by reproduction.

The initial pattern constitutes the *seed* of the system. The first generation is created by applying the above rules simultaneously to every cell in the seed—birth and deaths occur simultaneously, and the discrete moment at which this happens is sometimes called a *tick* (in other words, each generation is a pure function of the preceding one). The rules continue to be applied repeatedly to create further generations.[1]

2 Outline

Open a new, MATLAB script function. Make a header with your name, date, etc.

1. Initialize
   (a) $n = 50$ as the number of rows
   (b) d as a random number in the interval $[0, 1]$ (i.e. population density)
2. Construct *Anow* has a n-by-n matrix of random numbers in the interval $[0, 1]$
   (a) Set $Anow < d$ (this makes a matrix full of ones and zeros for the "seed" of the system)
3. Within a for loop (over the time ticks)
   (a) Use the sparsity command `spy` on *Anow* to view the current generation.
   (b) Let *Anow* be the output of a separate, MATLAB function `NextGeneration(Anew,n)`
      i. Initialize *Anext* as a n-by-n matrix full of zeros (this will be the "next generation" matrix)
      ii. Write that MATLAB function to perform the 4 rules of "Life" from the prompt
      iii. Caution: the hardest part of this program is to deal with the boundary conditions.
   (c) Insert a `pause` command to slow down the loop and create an "animation"
   (d) Reassign *Anow* to *Anext*
4. Show the last result of *Anow*

[1] Source: `http://en.wikipedia.org/wiki/Conways_Game_of_Life`

3 Hint

Consider the 5-by-5 matrix

$$A = \begin{bmatrix} 17 & 24 & 1 & 8 & 15 \\ 23 & 5 & 7 & 14 & 16 \\ 4 & 6 & 13 & 20 & 22 \\ 10 & 12 & 19 & 21 & 3 \\ 11 & 18 & 25 & 2 & 9 \end{bmatrix}$$

The MATLAB command `sum(sum( A(2:4,2:4) )) - A(3,3)` returns 104, the sum of the middle 3-by-3 matrix's elements not including the middle element:

$$104 = 5 + 7 + 14 + 20 + 21 + 19 + 12 + 6$$