Math 463: Introduction to Mathematical Biology

Computer Lab Assignment #2

The goal of this lab is to give you some practice solving discrete equations with MATLAB. Your task is to write some simple code that will iterate the discrete models below.

- Login and open MATLAB
- Click on the 'New M-file' Icon in the top left corner of the MATLAB menu. It looks like a blank sheet of paper.
- Type clear (return)
- Set your initial conditions, e.g. "x(1) = 1;" Note that MATLAB does not allow zero indices so you'll have to shift everything up by one. The semicolon at the end of the command tells MATLAB to perform the command, but not to print the result to the screen.
- Define the number of iterations you want to compute: e.g. N = 15;
- Write a for-loop to compute the iterates
- Click on the 'Save' Icon to give your file a name and save it; e.g. filename.m
- Type 'filename' in the MATLAB command window to run your program.

For example, to solve the simple model $x_{n+1} = -.5x_n$, enter the following code:

```
clear
x(1) = 10;
N = 20;
for n = 1:N
x(n+1) = -.5*x(n);
end
n = 1:1:N+1';
plot(n,x,n,x,'bo')
```

Use MATLAB to solve the following discrete models and plot your results to turn in. The subplot(i,j,k) command allows you plot several graphs on the same sheet of paper. For example:

```
subplot(2,2,1), plot(n,x)
```

breaks up your paper into 2 rows and 2 columns of graphs. The number 1 tells MATLAB to plot the current graph in the first position.

Use the subplot command to plot problems 1-4 on the same sheet of paper. For problems 1-4, compute the exact solution and plot it on the same axis as the numerical solution (eg use circles for the analytical solution and a straight line for the computed solution). For problems 5 and 6, plot the numerical solutions on the same piece of paper. What can you say about the eigenvalues of the equations?

HINT: MATLAB cannot deal with zero as an index. This means that you will not be able to use x_0. Instead, use the given information to start your numerical iterations at n = 1.

1. $x_{n+1} - 5x_n + 4x_{n-1} = 0, \quad x_1 = 9,\ x_2 = 33$
2. $x_n - x_{n-2} = 0, \quad x_1 = 3, x_2 = 5$
3. $x_{n+2} - 2x_{n+1} + x_n = 0, \quad x_0 = 1,\ x_1 = 3$
4. $x_{n+2} - x_{n+1} + x_n = 0, \quad x_0 = 6,\ x_1 = 2$
5. $x_{n+1} = x_n/4 + 3y_n,\ y_{n+1} = -x_n/8 + y_n \quad x_0 = 0,\ y_0 = 1$
6. $x_{n+1} = x_n + y_n,\ y_{n+1} = 2x_n \quad x_0 = 1,\ y_0 = 0$

7. Simulate the Segmental Growth Problem: $a_{n+1} - (1+q)a_n - ra_{n-1} = 0,\ a_0 = 1$ try various values for q and r. How does changing these values effect the solution.

8. Simulate the Blood $C0_2$ problem: $C_{n+1} - C_n + \alpha\beta C_{n-1} = m$ for relevant values of m, α and β. HINT: Be sure to try $4\alpha\beta >$ and $4\alpha\beta < 1$.