MATH1070 Complex Systems Assignment One
This assignment consists of three parts. It is worth 20% of your marks for the course. It is due Friday, 28th October, 2005 at 4pm.

Part One: Chaos (4 marks)

1. Print out your fully labelled bifurcation diagram from Prac 1, Task 3. Also include the MATLAB code you used to create the data. **2 marks**
2. Use your bifurcation diagram to find a value of 'r' which produces period-3 dynamics. (You may want to 'zoom-in'.)

   Use this value of 'r' and plot the dynamics from two different initial conditions. Include a legend just like in Prac 1, Task 1. Discuss what happens to the two different initial conditions and submit your properly labelled plot. **1 mark**
3. Repeat Prac 1, Task 2 with the value of 'r' that produces period-3 dynamics. By drawing on the plot, show the phase space trajectory for the first 10 time steps from an arbitrary initial condition. Submit your work. **1 mark**

Part Two: Agents and Patterns (6 marks)

1. Compare and contrast the NetLogo models Slime, Termites and Flocking. (At least 2 overall similarities and one difference for each model.) Consider both the local mechanisms and global behaviour. **2 marks**
2. Compare and contrast Fur, Segregation, Voting and Ising. (At least 2 overall similarities and one difference for each model.) Consider both the local mechanisms and global behaviour. **2 marks**
3. Run the 'randomsandpile' model until it becomes critical then clear all the data. Now run the model for at least 1000 generations in the critical regime. Use 'Export - Output' to create a csv file. Import the file to MATLAB and plot a frequency count of the avalanche size data on both linear and log-log axes with bins of size 5. Use markers instead of a bar graph.

   Label both plots and print them out. Draw the straight line which you think best fits the data on the log-log axes. **1 mark**

   In MATLAB, calculate the mean and median of the avalanche sizes, the maximum avalanche size, and the number of avalanches of size one. Interpret these statistics and discuss how they are represented in your plot. **1 mark**

Part Three: Cellular Automata (5 marks)

1. Find the smallest space ship in the 'Brians Brain' CA. Determine its speed, period and possible directions. How many white cells and red cells does it consist of? Why can't there exist a smaller space ship? **1 mark**
2. Why can't any 'still life' exist in the Brian's Brain CA? **0.5 marks**
3. In the Brians Brain CA look at the number of possible states for each cell and the size of each cells neighbourhood. How many different neighbourhood configurations are possible? **1 mark**
4. List two different ECA rules that results in a fractal triangular pattern when started on a single cell (there are quite a few). Describe each rule as concisely as possible. (It will be useful to display the rule graphically.) **1 mark**
5. In the Game of Life what is the name of the pattern that has a line of 4 live cells as its 'grandparent'? **0.5 marks**
6. In the Game of Life draw a line of 10 live cells. What is the period of the oscillator it leads to? **0.5 marks**
7. In the Game of Life run the 'B-heptomino' pattern. How many space ships are produced? What is their speed and direction? **0.5 marks**