Alice Project

There are two parts in this project. The first part on simulation of chaos needs to be done individually. The second part is self designed and can be done individually or in group of up to 4 members.

Part I: Simulation of Chaos (40%)

In this part, you will simulate a chaos model and observe the chaotic behavior in the animation. This page contains general information on chaos theory using excerpts from en.wikipedia.org. The chaos model and requirements for your animation are described on the next page.

From http://en.wikipedia.org/wiki/Chaos_theory:

“Chaos theory is a field of study in mathematics, with applications in several disciplines including physics, economics, biology, and philosophy. Chaos theory studies the behavior of dynamical systems that are highly sensitive to initial conditions, an effect which is popularly referred to as the butterfly effect. Small differences in initial conditions (such as those due to rounding errors in numerical computation) yield widely diverging outcomes for chaotic systems, rendering long-term prediction impossible in general.”

“Chaos theory is applied in many scientific disciplines: mathematics, programming, microbiology, biology, computer science, economics, engineering, finance, meteorology, philosophy, physics, politics, population dynamics, psychology, and robotics.

Chaotic behavior has been observed in the laboratory in a variety of systems including electrical circuits, lasers, oscillating chemical reactions, fluid dynamics, and mechanical and magneto-mechanical devices, as well as computer models of chaotic processes. Observations of chaotic behavior in nature include changes in weather, the dynamics of satellites in the solar system, the time evolution of the magnetic field of celestial bodies, population growth in ecology, the dynamics of the action potentials in neurons, and molecular vibrations. There is some controversy over the existence of chaotic dynamics in plate tectonics and in economics.

A successful application of chaos theory is in ecology where dynamical systems such as the Ricker model have been used to show how population growth under density dependence can lead to chaotic dynamics.

Chaos theory is also currently being applied to medical studies of epilepsy, specifically to the prediction of seemingly random seizures by observing initial conditions.

from http://en.wikipedia.org/wiki/Butterfly_effect:

“In chaos theory, the butterfly effect is the sensitive dependence on initial conditions; where a small change at one place in a nonlinear system can result in large differences to a later state. The effect derives its name from the theoretical example of a hurricane's formation being contingent on whether or not a distant butterfly had flapped its wings several weeks before.”
The chaos model for your simulation is \( a = 3.9a(1-a), 0 < a < 1 \). It is highly sensitive to the initial value of \( a \).

Here are the \( a \) values of the first 9 iterations of this model for the initial values of 0.25 and 0.26, which shows significant differences after iteration 5.

<table>
<thead>
<tr>
<th>iteration</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>( a )</td>
<td>0.2500</td>
<td>0.7312</td>
<td>0.7664</td>
<td>0.6981</td>
<td>0.8219</td>
<td>0.5709</td>
<td>0.9554</td>
<td>0.1662</td>
<td>0.5404</td>
</tr>
<tr>
<td>( a )</td>
<td>0.2600</td>
<td>0.7504</td>
<td>0.7305</td>
<td>0.7677</td>
<td>0.6955</td>
<td>0.8259</td>
<td>0.5607</td>
<td>0.9606</td>
<td>0.1474</td>
</tr>
</tbody>
</table>

A movie of an Alice animation of the model is available at [http://www.cs.clarku.edu/~lhan/courses/cs120/chaos_size.mov](http://www.cs.clarku.edu/~lhan/courses/cs120/chaos_size.mov). And the \( a \) values are used to determine the sizes of the balls.

You need to write an Alice program that produces a similar animation. Here are the requirements.

1. Your animation should have two objects, each having a visible attribute, such as its size or its x (or y or z) position, whose value is determined by the \( a \) value in the chaos model. For each object, different \( a \) values should cause some visible changes to the object.

2. Your animation should let the user specify initial values for the two objects and the number of iterations, and then simulate the chaos model for the given initial values and number of iterations.

3. Programming wise, you should first work on one object and write a method for it called chaosSimulation that simulates the chaos model and changes the object accordingly, e.g. by changing its size or location.

   The chaosSimulation method should have two parameters: initialVlue and numberOfIterations.

   It should use a loop to simulate the chaos model for the numberOfIterations of times.

4. In the world.myFirstMethod, first use some constant arguments, such as 0.25 for initialVlue and 10 for numberOfIterations, to test and debug the chaos simulation method.

   After making the simulation method work, generalize world.myFirstMethod to make it ask for and get user input for initial size and number of iterations. You should use while loops to keep on asking for user inputs, with useful prompts to the user, until getting valid input values, before passing these values to the chaos simulation method.

5. After making the simulation and world methods works for the first object, create the second object as a copy of the first object and position both objects properly in the scene. Then add statements to your world.myFirstMethod to get user input for the initial value of the second object and make two objects do chaos simulation together.
Part II: Self-Designed Project (60%)

You can do this part of the project on your own or with partners (up to 4 students in a group).

You have a choice of two scenarios:

1) A game of some sort. You must devise a score-keeping mechanism to let the user know when they have won (or completed) the game.

2) An animation that must run for at least (0.5*group size) minutes. You get to choose the topic of your animation. Here are some ideas: an electronic greeting card, a commercial for advertising some product, a demonstration of one or more (challenging) concepts (e.g. in math, sciences...), a short movie of a story of your own design, a recreation of your favorite movie/TV scene, etc.

Here are the requirements:

a) devise a storyboard for the overall animation and prepare the storyboard as something you can show the class (not just scrawled notes on a sheet of scruffy paper).

b) Regardless working individually or as a group, each student must define at least one object that
   • defines at least one property variable, and uses the newly defined property variable(s) in the code.
   • defines at least two methods and at least one function that are used in your animation. At least one of your methods must have parameters and be used at least twice with different parameter values.
   • Use at least one loop, such as a for or while statement, somewhere in the code.

c) For a group project, you need to use all your objects, in a logic way, in the final simulation. So the group members must work together to complete the storyboard and decide "who is doing what." Each group member saves out his/her object as a new class. And then group members meet to create a new world, with at least one object from each of new classes developed by group members.

d) All code needs to be properly documented.

e) Write an individual project report that describes how you split the work with your partners, the major functionality and flow structure of your overall code and your newly added methods and function(s)