1. There are two variables in the logistic map equation, *viz.*, x_n and r. Which of these is the *parameter*?

   x_n

   r

2. Can a change in the logistic map's *parameter* cause a change in the topology of the attractor, *i.e.*, a bifurcation in the dynamics?

   Yes

   No

3. Point your browser to:

   `http://tuvalu.santafe.edu/~jgarland/LogisticTools.html`

   Use the application to find the r value where the fixed-point dynamics *appear to* bifurcate to a two-cycle. *Hint: Using the "Start Animation" feature of this application will be helpful in this exploration. When using the "Start Animation" feature, keep the number of initial iterates* ≤ 50 *or the program will slow down. The "Remove Iterate" feature may also be helpful in removing transient behavior.* At what r value does this bifurcation in the logistic map dynamics occur?

   $r = 2.99$

   $r = 3$

   $r = 3.01$

4. Explore different initial conditions ranging from $0.1 < x_0 < 0.9$ with $r = 3.2$. Do all orbits limit to the same 2-cycle?

   Yes

   No

5. Is that two-cycle an attractor?

   Yes

   No

6. Using the same application, slowly raise r from 3.4 to 3.5. Between these two r values the dynamics will bifurcate from a 2-cycle to an n-cycle, where n is:

   $n = 2$

   $n = 3$

   $n = 4$

   $n = 5$

7. Again, slowly raise the r parameter from 3.5 to 3.551. Another bifurcation will occur resulting in a stable attracting n-cycle, where n is what? *Thought question:* do you see a pattern of bifurcations emerging?

   $n = 5$

   $n = 6$

   $n = 7$

   $n = 8$