Nonlinear Dynamics: Mathematical and Computational Approaches

Lead instructor: Liz Bradley

Important things to remember when taking tests:

- **Tests auto-save your answers!** Don't worry if you close the page or walk away from the computer, all of your selections will be remembered when you come back.
- When you are finished, click the "Submit" button at the bottom of the test. **Be careful: submitting tests cannot be undone.**

Instructions

You may use any course materials, websites, books, computer programs, calculators, etc. for this test. Just don't ask another person for the answers or share your answers with other people. Be aware that simply typing the question text into google is unlikely to get you directly to the right answer; you're going to have to read what you find there in order to extract that answer, and the course videos are probably a faster way to do that.

"Experts" notes clarify situations that haven't been covered in this course, but that may introduce subtleties into the exam answers. Do not worry about them unless you understand the terms and issues in those notes.

If you have questions about this test, please email us at nonlinear@complexityexplorer.org rather than posting on the forum.

Note: the placement of the radio buttons for questions 2-4 in the downloadable pdf file for this unit test is different than their placement in the web version. In the former, the buttons are to the bottom left of the images from which you are to choose; in the latter, they're to the top left. Since the pdf version is generated automatically by the website software, there's no way for me to fix this. So please be careful!

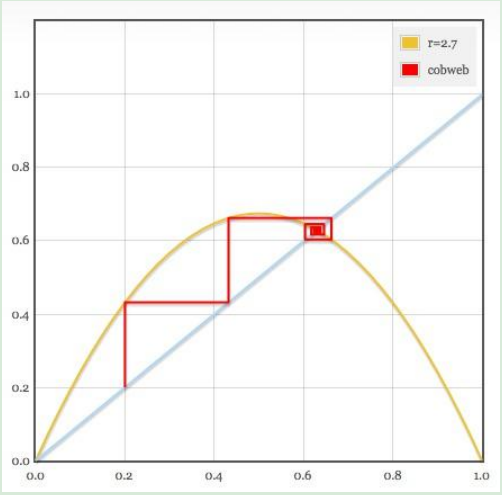
Question 1

In what range does the period-two window of the logistic map exist?

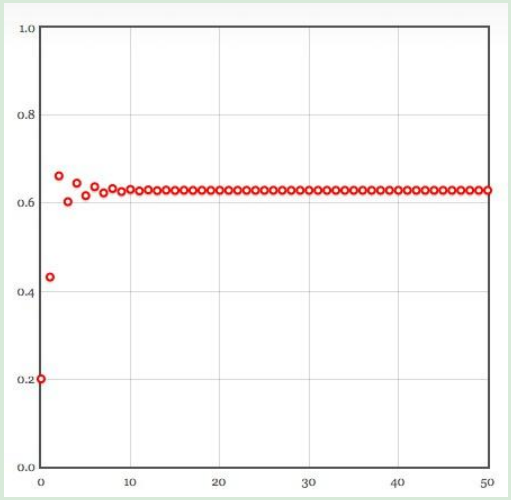
- ✔ $3 \leq r \leq 3.44$
- $0 < x_0 < 1$
- $2.9 < r < 3.5$

Question 2

Consider this return map:



Which of the time-domain plots below matches that behavior?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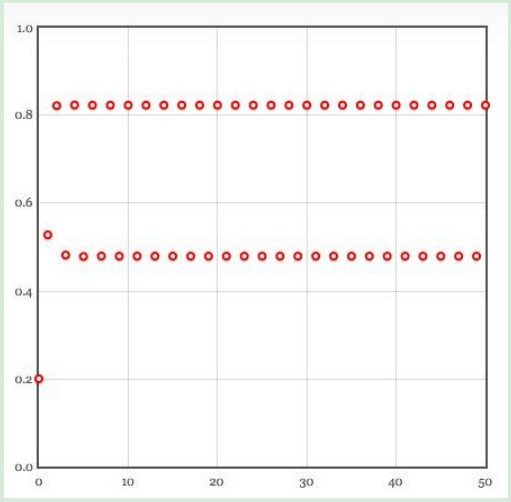
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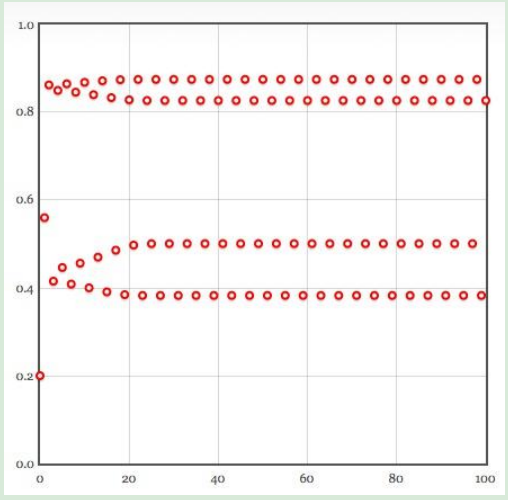
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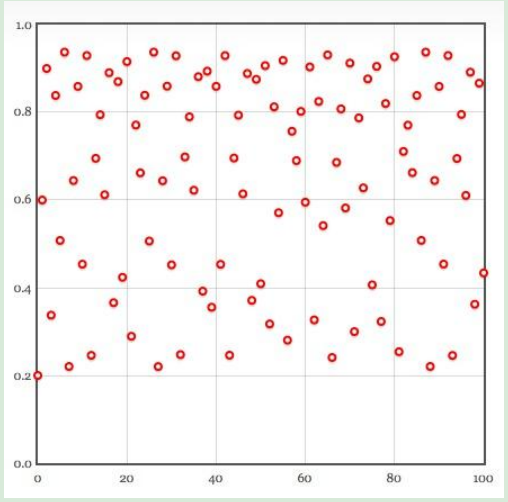
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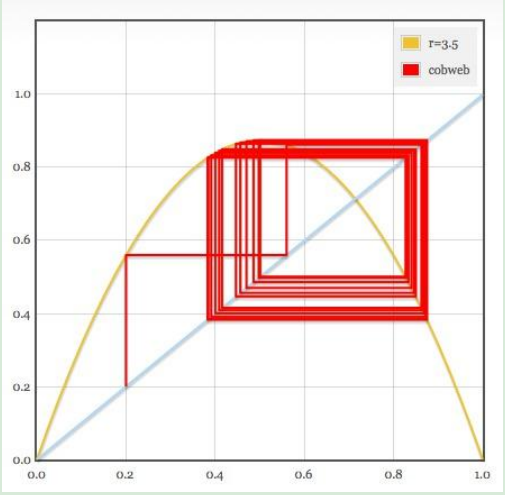
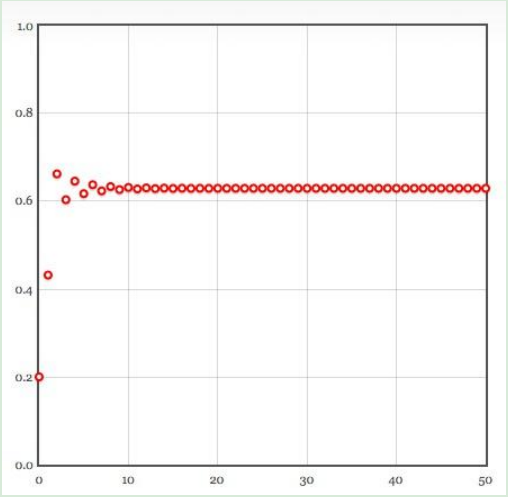
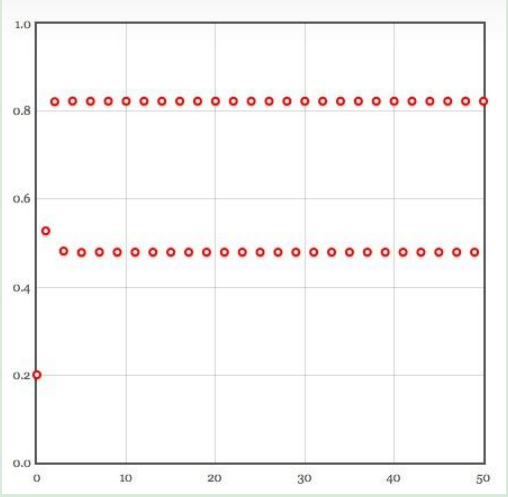
Question 3

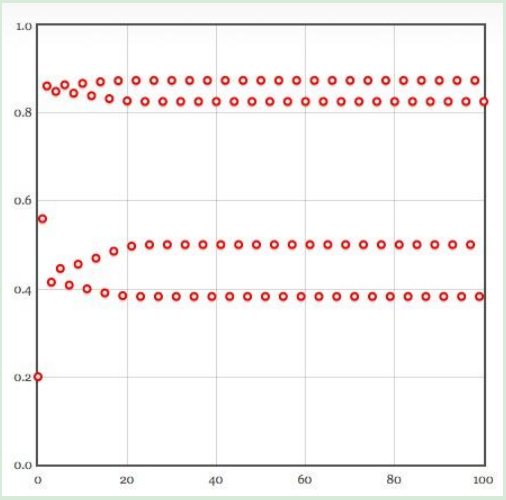
Consider this return map:

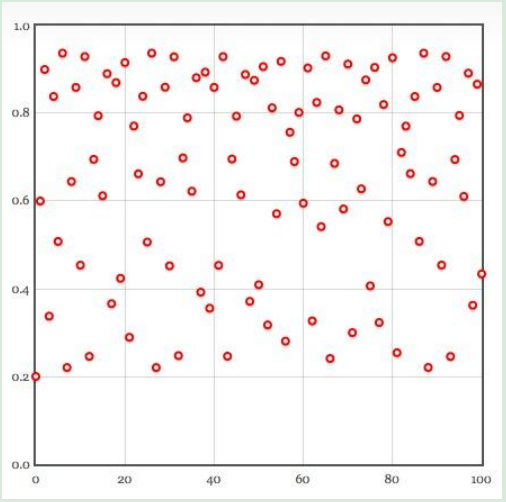


Which of the time-domain plots below matches that behavior?



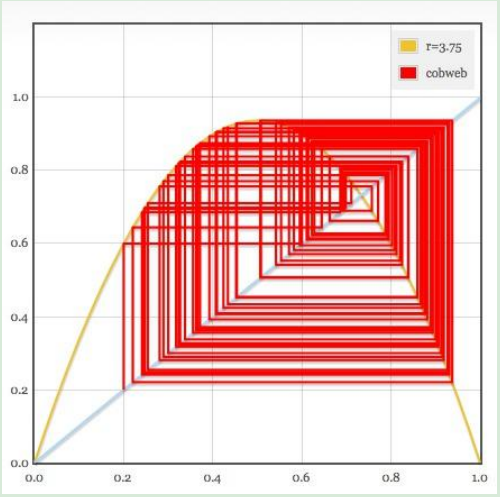




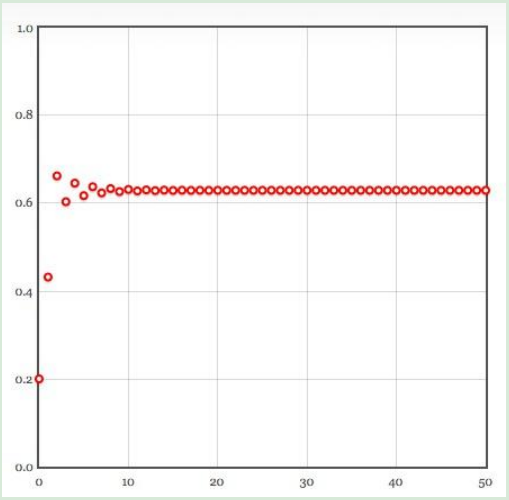


Question 4

Consider this return map:



Which of the time-domain plots below matches that behavior?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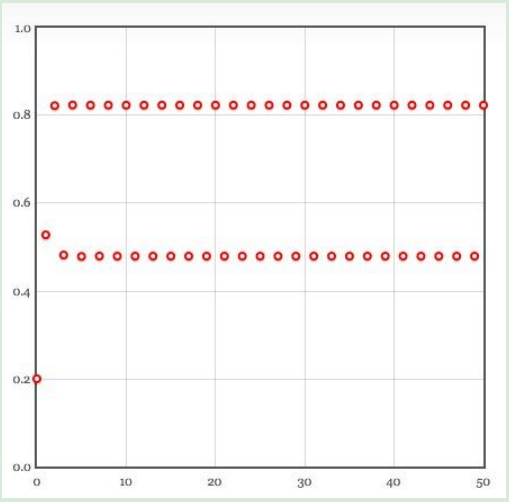
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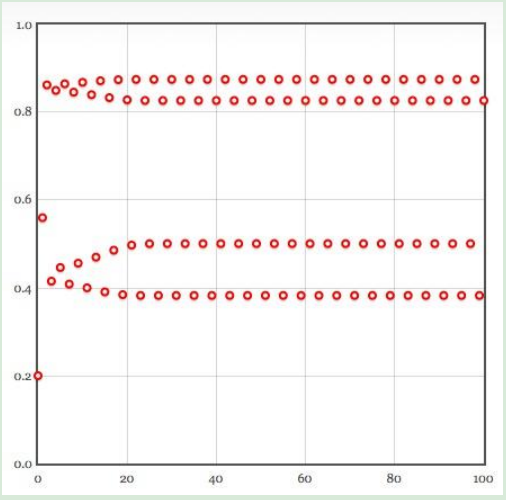
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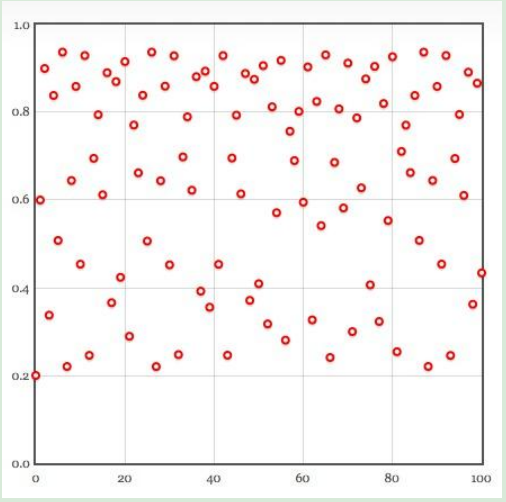
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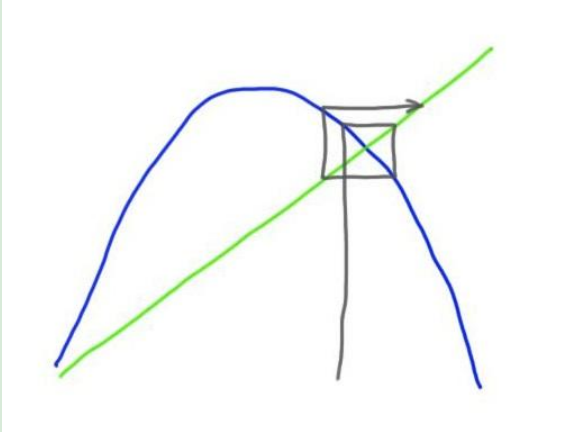
Question 5

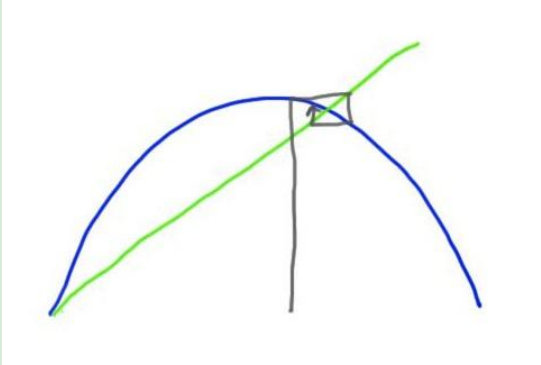
Does this cobweb plot depict a stable fixed point?



- Yes
- ✔ No

Question 6

Does this cobweb plot depict a stable fixed point?



- ✔ Yes
- No

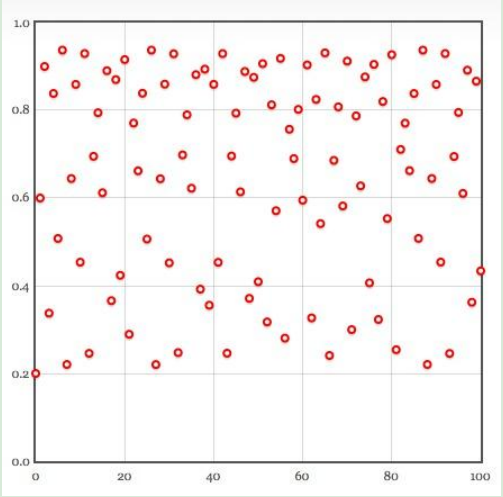
Question 7

What geometric feature(s) of the cobweb diagram dictate(s) whether or not a fixed point is stable?

- The slope of the $x_{n+1} = x_n$ line
- The value of x_0
- The height of the apex of the parabola that corresponds to the logistic map: $rx_n(1 - x_n)$
- ✔ The slope of the parabola at its intersection with the $x_{n+1} = x_n$ line.

Question 8

The trajectory in this plot is ...



- converging to a fixed point
- diverging
- ✔ probably chaotic

Question 9

If you increase r in the logistic map beginning at 2.8, what happens next?

- Nothing
- A bifurcation to chaos
- ✔ A bifurcation to a two-cycle

Question 10

The bifurcation diagram of the logistic map is fractal.

- ✔ True
- False

Question 11

The bifurcation diagram of the logistic map is self-similar.

- ✔ True
- False

Question 12

The Feigenbaum number holds for all maps.

- True
- ✔ False

Question 13

The Feigenbaum number holds for all flows.

- True
- ✔ False

Question 14

If you ran your bifurcation diagram code from problem 1 of homework 2.2 for $2 < r < 3.9$ with $x_0 = 0.2$, an Δr of 0.1, while discarding five points at each step and plotting the next 200, would you get good results?

- Yes
- ✔ No; you haven't discarded enough transient points to make the plot look good
- No; you haven't plotted enough points at each step to bring out the structure.
- No; that's not a good initial condition.

Question 15

Run your bifurcation diagram code from problem 1 of homework 2.2 to zoom in on the range $3.84 \leq r \leq 3.8571$ and $0.4 \leq x \leq 0.6$

Compare the structure that you see in this region to that in the overall plot.

- ✔ They are similar.
- They are absolutely identical.
- There is no resemblance.

Question 16

What word goes in the ... in this statement? "... chaotic systems have fractal structure"

- ✔ Some
- All
- No

You got 16 out of 16 questions correct

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