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.

Please complete the course evaluation here.

Question 1

The UC Santa Cruz Chaos Cabal's prediction strategy for roulette was one of the first applications of delay-coordinate embedding.

- ✔ True
- False

Question 2

The basic model in the UC Santa Cruz Chaos Cabal's prediction strategy for roulette was...

- An ARMA ("autoregressive moving average") model.
- ✔ Linear models built in small patches of the embedded trajectory.
- Lorenz's method of analogues.
- A linear model of the embedded trajectory.
- A neural net.

Question 3

Why is it useful to embed scalar time-series data before building a prediction model of a deterministic dynamical system?

- ✖ It exposes the temporal patterns in spatial form.
- If you don't do that, the false crossings created by the projection involved in the measurement can make your predictions wrong.
- Both of the above.
- Neither of the above.

Question 4

How can you modify Lorenz's method of analogues to make it less sensitive to noise when working with chaotic systems?

- Use a low-pass filter on the data first.
- ✔ Rather than looking for each point's nearest neighbor and using the forward image of that point as the forecast, look for a bunch of nearest neighbors and average their forward images.
- Run it on lots of different points and average the resulting forecasts.

Question 5

If a feedback controller like a thermostat uses positive feedback, what will the results be?

- ✔ The system state will saturate.
- The system state will stabilize at the desired setpoint.
- The system state will oscillate.

Question 6

OGY control can be used to stabilize a chaotic system **at** any point in its state space.

- ✖ True
- False

Question 7

OGY control employs local-linear control to stabilize a chaotic system at the desired destination. What role does the denseness with which trajectories cover chaotic attractors play in OGY control?

- ✔ Reachability: assuring that the system trajectory will get close enough to the desired destination so that the linear controller can grab & stabilize it.
- Leverage: it's how you exploit sensitive dependence on initial conditions to get to the desired destination faster.
- No role at all.

Question 8

What kinds of physical systems has OGY control been applied to?

- Heart fibers.
- Hippocampus cells.
- Magnetoelastic ribbons.
- Electronic circuits.
- ✔ All of the above.
- None of the above.

Question 9

Name a satellite in the solar system that is tumbling chaotically right now.

- Earth's moon.
- ✔ Saturn's moon Hyperion.
- Mars's moon Phobos.
- Jupiter's moon Ganymede.

Question 10

What's an orrery?

- A computer program that solves the ODEs that model how mass falls into a black hole.
- ✔ A machine (physical or computational) that simulates the orbits of the planets in the solar system.
- Something else.

Question 11

Chaos is a potential explanation for the existence of at least one of the Kirkwood gaps in the asteroid belt between Mars and Jupiter.

- ✔ True
- False

You got 9 out of 11 questions correct