Introduction to Complexity (Fall, 2014)

Instructions 1

You may use any course materials, websites, Netlogo models, calculators, etc. for this test. Just don't ask another person for the an share your answers with other people.

Question 2

Aristotle and Newton differed in their beliefs in the following way:

- A. Aristotle believed that the earth revolved around the sun, whereas Newton believed that the sun revolved around the earth.
- B. Aristotle believed that objects set in motion will stay in motion, whereas Newton believed that objects set in motion would slow down and eventually stop
- C. Aristotle believed that there were two separate sets of laws, one for behavior in the "heavens" and one for behavior on earth. Newton believed that the san applied to both.
- D. Aristotle believed that the planets move in perfect circles about a non-moving sun, whereas Newton showed that they move in ellipses.

Question 3

Pierre Simon Laplace believed that:

- A. The existence of sensitive dependence on initial conditions makes perfect prediction impossible.
- B. If we had perfect knowledge of the positions of all elements of the universe and all forces acting on them, perfect prediction would be possible in principl
- C. Newton's laws are imperfect, which makes perfect prediction impossible.

Question 4

According to Henri Poincaré:

- A. Perfect prediction is impossible for any phenomenon in nature.
- B. If we had perfect knowledge of the positions of all elements of the universe and all forces acting on them, perfect prediction would be possible in principl
- C. In some systems, sensitive dependence on initial conditions might make perfect prediction impossible in practice, due to errors or imprecision in measur conditions.
- D. Newton's laws are imperfect, which makes perfect prediction impossible.

Question 5

Suppose a population grows without limit, according to the formula

$n_{t+1} = birthrate * n_t$

If *birthrate* = 4 and the initial (year 0) population $n_0 = 1$, which is the correct formula for the population at year t (i.e., n_t)?

- A. $n_t = 4t$
- *B.* $n_t = 4t^2$
- C. $n_t = t^4$
- D. $n_t = 4^t$
- E. $n_t = 4 * 2^t$

Question 6

Recall that the logistic model is:

$n_{t+1} = (birthrate - death\text{-}rate) * [n_t - (n_t^2 / k)]$

where k is the maximum population (or carrying-capacity).

Suppose that *birthrate* = 4, *death-rate* = 0, k = 20, and the initial population n_0 = 20.

Using this model, what is n_{12} ?

- A. 20
- B. 21
- C. 1
- D. 0
- E. 4

Question 7

For the logistic model (given in question 6 above), let *birthrate* = 5, *death-rate* = 0, k = 100 and n_0 = 20. What is the fixed-point of the n
these values?

- A. 50
- B. 80
- C: 20
- D. 100
- E. 0

Question 8

Recall that the logistic map is:

$$x_{t+1} = R(x_t - x_t^2)$$

where x = current-population / carrying-capacity and R = birthrate – deathrate.

Let R = 1.6. What is the fixed-point attractor for this value of R, starting from any

x_0 (assuming x_0 is greater than 0 and less than 1) ?

- A. 0.375
- B. 0.450
- C. 0.2
- D. 0.355
- E. 0.575

Question 9

For the logistic map, let $R = 3.2$. What kind of attractor does this yield?

- A. Fixed point attractor
- B. Period 2 attractor
- C. Period 4 attractor
- D. Period 8 attractor
- E. Chaotic attractor

Question 10

Which of the following can you conclude from the logistic map bifurcation diagram?

- A. When R is between 2.4 and 3.0, the logistic map has a fixed point that increases as R increases.
- B. When R is between 3.0 and 3.4, the logistic map has a period-2 attractor in which, as R increases, the two values in the attractor get closer together.
- C. The onset of chaos for the logistic map is between 3.4 and 3.5.

Question 11

A system exhibits *deterministic chaos* if:

- A. Chaos occurs for only some values of x_0
- B. If two initial conditions are very close, their trajectories under the system will also be close.
- C. The system is deterministic, but its behavior can be impossible to predict with perfect accuracy.

Question 12

Which of these best describes what Feigenbaum's constant measures?

- A. The distance between bifurcations in the logistic map as R increases
- B. The rate at which the distance between bifurcations in the logistic map decreases as R increases
- C. The increase in the periods of attractors in the logistic map increases as R increases