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Group # 1 Artificial Life

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22.) Suppose a netto growth of a population of 1.5% per week. How long will it take until this population has doubled its size?

$$x_t = x_i(1+r)^t$$

$x_t \rightarrow$ population after t years

$x_i \rightarrow$ initial population

$r \rightarrow$ growth rate

$t \rightarrow$ time period.

$$x_t = 2x_i$$

$$\cancel{x_i}(1+r)^t = 2\cancel{x_i}$$

$$\cancel{t =}\ (1+r)^t = 2$$

$$t = \frac{\log 2}{\log(1+r)} \longrightarrow \text{formula}$$

$$r = 0.015$$

weeks

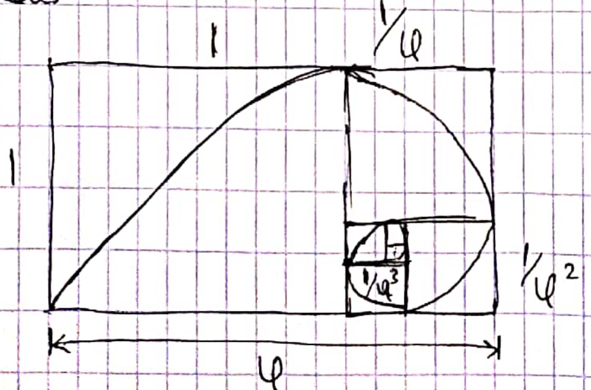
$$t = \frac{\log 2}{\log(1+0.015)} = \frac{\log 2}{\log(1.015)} = 46 \text{ years.}$$

2

$$t = 46 \text{ years.}$$

23.) Golden Spiral is a logarithmic spiral whose growth factor is φ (Golden ratio). The golden spiral gets wider by a factor of φ for every quarter ~~fact~~ turn it makes.

The golden ratio divides a given interval in a very special way into two pieces.



[ratio $\Rightarrow$ 1:1.6]

1

24.) Derive a formula to calculate the limit β of the ratios of successive terms of Fibonacci sequence analytically, and write a small program to check this limit experimentally.

$$F_{n+2} = F_n + F_{n+1}$$

$$\beta = \lim_{n \to \infty} \frac{F_{n+1}}{F_n}$$

$$= \lim_{n \to \infty} \frac{1}{\frac{F_{n+2} - F_{n+1}}{F_{n+1}}}$$

$$\beta = \frac{1}{\beta - 1} = \frac{1 + \sqrt{5}}{2}$$

$$\underline{\beta = \frac{1 + \sqrt{5}}{2}} = \phi \text{, where } \phi = \frac{1+\sqrt{5}}{2} \text{ is the golden mean.}$$

2

25.) Derive a formula to determine the fixpoint x^* depending on a for the following iterated function (logistics map): $x_{i+1} = a * x_i * (1 - x_i)$
For a fixpoint of an iterated function the value is no longer changing thus $x^*_{i+1} = x^*_i$. Draw a diagram for the fixpoint $x^*(a)$ as a function of a with $0.0 < a < 4.0$.

$$x_{i+1} = x_i * a * (1 - x_i)$$

$$x_{i+1} = x^*_i$$

$$\cancel{x^*_i} = \cancel{x^*_i} * a(1 - x_i^*)$$

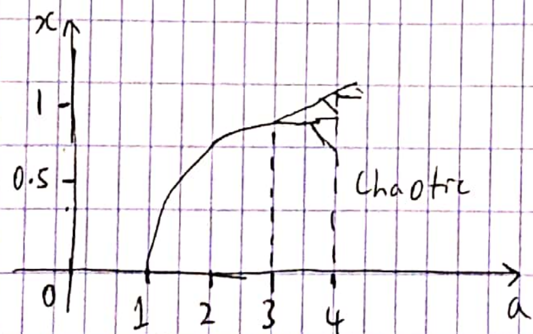
$$1 = a(1 - x_i^*)$$

$$1 = a - a x_i \Rightarrow \underline{x_i^* = 1 - 1/a}.$$

1pt

$0 < x_i < 1$

$1 < a < 4$



Dynamic Chaotic System

26) Look-and-say sequence has rules that look at the i-th element and say what is this element, then write it as next i+1-th element.

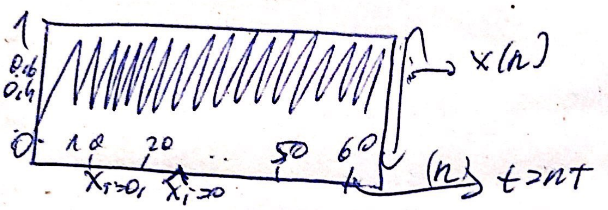
Here is 6 steps of '2020'

2020
12101210
1112111011121110
3112311031123110
132112132110132112132110
1113122112111312211011131221121113122110
311311222112311311222110311311222112311311222110

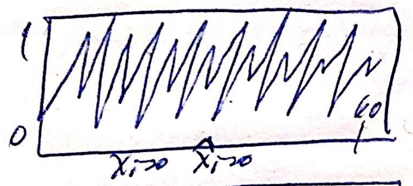
1

27) $x_{i+1} = a * x_i * (1-x_i)$ is a logistic map function that have different plots as follows for 60 iterations,

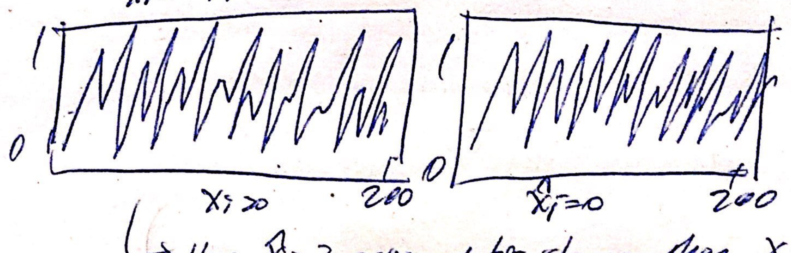
$\alpha = 3.3$



$\alpha = 3.51$



$\alpha = 3.75$



3

Here x_i is getting a bit sharper than x_i but in $\alpha=3.3$ and 3.51 cases, they are almost identical. For $\alpha=3.3$, system has oscillation class-2 behavior, for $\alpha=3.51$ system has oscillation in class 2 behavior, for $\alpha=3.75$ system has chaotic class 3 behavior. And the entire evolution of different r functions are looking like this diagrams