Autonomous Intelligent Systems,
Institute for Computer Science VI, University of Bonn

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Exercises for Artificial Life (MA-INF 4201), SS15

Exercises sheet 5, till: Mon 18.5.2015

11.5.2015

Group	Name	31	32	33	34	35	36	Σ

Assignment 31 (2 Points)

Suppose a netto growth of a population of 1.7% per year.
How long will it take until this population has doubled its size?
Please derive a formula for the number of years necessary to reach the doubling.

Assignment 32 (1 Points)

Prove or disprove the following sentence in a formal way:
The Fibonnaci sequence is rising faster than the exponential function.

Assignment 33 (3 Points)

Consider the following 1-dimensional cellular automaton, with a size of $S = 101$ cells $i = 0, 1, 2, ..., 100$, r=1, $k = 65536$ with $a_i = 0, ..., 65535$ and the totalistic rule:
$a_i(t+1) = floor\Big(1/3 * [1.0 * a_{i-1}(t) + 1.0 * a_i(t) + 1.0 * a_{i+1}(t)]\Big)$

The left boundary (position 0) is set to the fixed value $a_0 = 42000$, the right boundary (position 100) is set to the fixed value $a_{100} = 420$.
In the beginning (t=0) all other cells $a_1(t = 0)$ to $a_{99}(t = 0)$ will be set to 0.
How will the behaviour of this cellular automaton be after a long time? Which class of behaviour will be reached? Describe in your own words how the long term behaviour is developing from the initial state.

Assignment 34 (2 Points)

What is a *Golden Spiral* ?
Please use your own words to explain it. Copying text from the internet is not sufficient.

Assignment 35 (3 Points)

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

$$\alpha = \lim_{n\to\infty} \frac{F_{n+1}}{F_n} \qquad F_{n+2} = F_n + F_{n+1} \qquad F_0 = 0, \quad F_1 = 1$$

Assignment 36 (4 Points)

Please determine the long-term behaviour of the following iterated function:
$x_{i+1} = a * x_i * (1 - x_i)$ for $a = 3.3$, for $a = 3.51$, and for $a = 3.75$
for the two starting conditions $x_{i=0} = 0.228734167$ and $\hat{x}_{i=0} = 0.228734168$.
Which class (Wolfram classification) of behaviour is reached?

The development of the difference between the values x_i and $\hat{x}_i$ is as well interesting, and helpful to understand the behavior.

Programming Assignment PA-C (10 Points, due date 1.6.15)

Write a C, C++, Java or Python Programm, that implements a Predator-Prey, Activator-Inhibitor System with an iterated function. Please notice, that it is reasonable to work with real values (type double).
Find a set of starting conditions for $x(0)$ and $y(0)$ and a set of parameters a, b, c, d, e, f that will yield an almost stable oscillation. Determine the mean population size $\bar{x}, \bar{y}$ for prey and predator when the system has reached an almost stable oscillation.
Increase the parameter a a bit. How is the influence of a on the mean values $\bar{x}, \bar{y}$?

$$\begin{aligned} x(i+1) &= x(i) + a * x(i) + b * y(i) + e * x(i) * x(i) \\ y(i+1) &= y(i) + c * x(i) + d * y(i) + f * y(i) * y(i) \end{aligned}$$

Draw the temporal development $x(i)$, and $x(i)$ of a stable oscillation with respect to the iteration number i, and draw a so-called phase plot, where $y(i)$ is plotted against $x(i)$ in a two dimensional diagram.
Use the program Gnuplot to draw this graph, and hand in the respective Gnuplot commands.

Extend the equations by two further terms, redo the steps above for the altered system and describe some of the major differences.

$$\begin{aligned} x(i+1) &= x(i) + a * x(i) + b * y(i) + e * x(i) * x(i) + g * x(i) * y(i) \\ y(i+1) &= y(i) + c * x(i) + d * y(i) + f * y(i) * y(i) + h * x(i) * y(i) \end{aligned}$$

Make sure your program is running correctly, and that you have sensible and resonable comments in your sourcecode.