Exercises Set 1

Oct. 28 2014

The main objective of this set of exercises is to get you started using python. Please install python together with "scipy", "matplotlib" and "numpy". You can use "http://www.scipy.org" as a starting point, it lists several distributions that should be fine for our needs.

Exercise 1: Conway's Game of Life

a) Download the the simple game of life script from *http://electronut.in/a-simple-python-matplotlib-implementation-of-conways-game-of-life* and get it running on your computer. Try to understand it.

b) The update rule in this script is very inefficient because it uses interpreter for-loops. Modify the script to use numpy array functions to make it more efficient. (Hint: have a look at the numpy.roll function).

Exercise 2: Lotka-Volterra-Model

The Lotka-Volterra model

$$\begin{aligned} \frac{d}{dt}x &= a\,x - c\,x\,y \\ \frac{d}{dt}y &= -b\,y + d\,x\,y. \end{aligned}$$

studied in the lecture is unrealistic because it allows for infinite populations. Real environments offer only limited resources and thus have only a finite capacity for supporting populations. This can be modeled using a variant of the logistic equation:

$$\frac{d}{dt}x = \alpha(1-x)x$$

where $\alpha \in \mathbb{R}^+$and

$$x := \frac{N}{K}$$

with N the current number of individuals and K the finite capacity.

a) Extend the Lotka-Volterra-model by introducing the logistic term for the prey animal population (x). Find the fixed points and analyse their linear stability.

b) Write a python script that draws the phase portrait of this extended Lotka-Volterra-model. There are two functions from "matplotlib" that you can use, "quiver" and "streamplot". Demos on how to use them can be found on the matplotlib website. Compare with your results from a).