Plotting dynamical systems is an art … (Alle effect)

Given $dN/dt = F(N) = rN\,(1 - N/K)$,

or $dN/dt = F(N) = rN - N/a\,(N - b)^2$,

it's important to be able to plot F(N) versus N (Graph 1) *by hand*.

Some general tips for plotting $dx/dt = F(x)$ are:

- What is F(x) at x = 0?
- What does F(x) do as x tends to infinity?
- Where does F(x) cross the X axis? i.e., where are fixed points.
- Where does F(x) have turning points?

When F(N) has several parameters (as in Allee effect — r, a, b), you have to make assumptions about the magnitude of the parameters, plot the graph, then change the relative magnitude of parameters, replot, etc, until you have identified all the possible cases.

Lecture 3 Introduction

- Cells/organisms live in unpredictable environments
- Fixed Points determine behaviour (*nothing interesting happens between fixed points in 1D, trajectories are monotonic*)
- If Fixed Points were unchangeable, they would be of limited use, e.g., cell needs to produce more or less of a protein under different conditions: *robust, adaptable, controlled*
- Bistability is a mechanism by which a system behaves differently by moving between fixed points as a parameter changes: (Spoiler: stable - unstable - stable FPs are bistable)
- Universality ~ idea that we don't need to find the exact equation to model a system, just be close enough to get the FPs correct

Background quiz

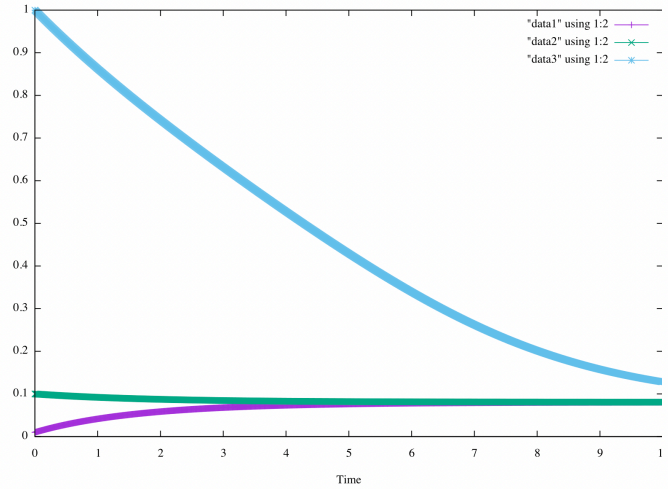
Background quiz: go.epfl.ch/turningpoint

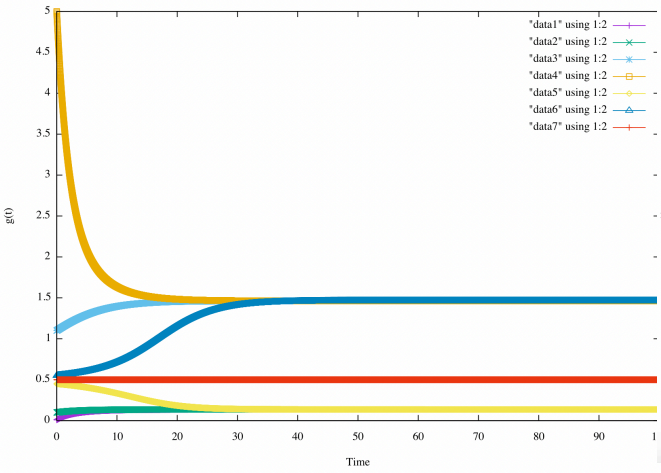
Session Id: julian23

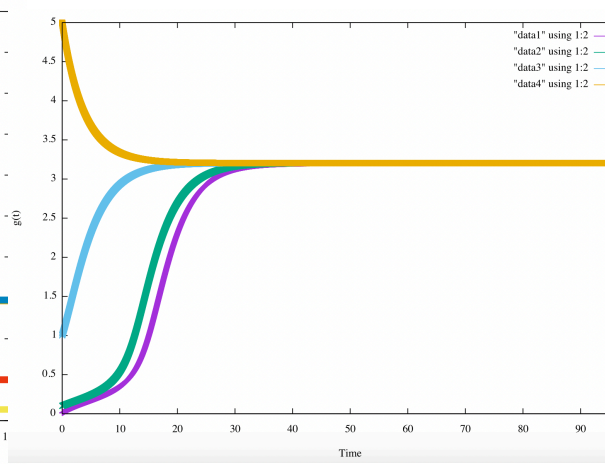
All input is anonymous; data are stored outside CH

Break

Presentation - forum







High degradation

s = 0.05
r = 0.7

g* ~ 0.08

Initial points

g0 = 0.01, 0.1, 1.0

s = 0.05
r = 0.5

g* ~ 0.14, 0.5, 1.46

g0 = 0.01, 0.1, 0.49, 0.5, 0.51, 1.0, 5.0

Low degrad.

s = 0.05
r = 0.3

g* ~ 3.2

g0 = 0.01, 0.1, 1.0, 5.0

Tricky points

- Apply various steps to understand an equation: non-dimensionalise, combine parameters, set one to zero/explore the other, start from intuitive limits (s = 0, r = 0, etc)
- Know what defines hysteresis/bistability in the dg/dt versus g plot (Graph 1)

  bistability = two stable states separated by an unstable one

  hysteresis = the jump between low and high [G] depends on history, i.e., it occurs at different values of the parameters s, r when going from low to high or high to low
- Know how the time evolution of the fixed point g* is related to the time variation of the parameters s, r
- Know how to plot $x/(1+x^2)$, $x^2/(1+x^2)$, $x^3/(1+x^3)$, $x^4/(1+x^4)$