Biological Physics II - Tutorial

SS 2019
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Week 3 - The Repressilator

Consider the following system of differential equations:

$$\dot{x} = \frac{1}{1+z^n} - \frac{x}{2}$$
$$\dot{y} = \frac{1}{1+x^n} - \frac{y}{2}$$
$$\dot{z} = \frac{1}{1+y^n} - \frac{z}{2}.$$

1) Using your knowledge from last weeks tutorial, explain all the terms in the biological context of cross-repressing genes, and ideally draw a sketch of the functioning of this system (genes, promoters, ...) called a repressilator.

2) Simulate the dynamics (i.e. solve the equations in time numerically) for $n = 2$ and $n = 6$. Plot the results and explain them. What would happen for $n \leq 1$?

3) Make a bifurcation diagram (x^*_{min} and x^*_{max} as a function of n) for n varying between 2 and 6. Reminder: in every case, choose the total time of the numerical integration scheme large enough so that the system can reach its fixed point or limit cycle.

4) Last week, we saw that the two cross-repressing gene model had two stable fixed points, corresponding to either one of the two genes being completely repressed. Whether the system evolved into one of the fixed points or the other depended on the choice of initial conditions. Such a system with multiple stable fixed points is called *multistable*. Does the repressilator also exhibit multistability?

Good luck!