Scientific Programming and Dynamic Modelling in Julia

April 27, 2022

1 Exercise 1

1.1 Setting up Julia

- Make sure you have installed Julia and an Editor with Julia support like VSCode
- Create a new folder for the lecture
- Launch Julia in the folder
- In the Julia REPL:
  - `]` brings you to the Julia packet manager
  - `;` brings you to a bash shell
- Activate a new local Julia environment in the Julia packet manager with `activate .` (We will talk a bit more about environments in the next lecture)
- Add the Plotting library with `add Plots` in the Julia packet manager
- When you write a script, always first activate the local environment with `import Pkg; Pkg.activate(".")`

1.2 Logistic Map

1.2.1 Code the Logistic Map

Write a function that returns a N steps long trajectory of a logistic map given an initial condition x_0 and parameter value r, where $1 < r < 4$.

1.2.2 Plot trajectories

Julia has one major plotting library `Plots.jl` that can use different backends for plotting (like Python's matplotlib or plotly). After importing the library with `using Plots`, a basic plot is called by `plot(x,y)`. If you want to add to an exisiting plot, use `plot!(x,y)`. You can adjust the plot by adding keyword arguments. Some common keyword arguments are:

- `ylims=[lower_limit, upper_limit]`
- `xlims=[lower_limit, upper_limit]`
- `title`
- `xlabel`
- `ylabel`
- all further keyword arguments are listed there: https://docs.juliaplots.org/stable/attributes/

For those how are familiar with Python, you can also use `matplotlib.pyplot` directly, there is a Julia wrapper, called `PyPlot.jl`. The syntax is almost the same as in Python. See its documentation (https://github.com/JuliaPy/PyPlot.jl) for how exactly it translates.

Now, plot trajectories of the logistic map for different values of $1 < r < 4$, that are $N = 50$ steps long.

1.2.3 Explore the Logistic Map

If you keep the r constant, e.g. at $r = 2.9$ and $r = 3.2$, what are you observing for different initial conditions x_0?

At which points $r_c \in [2.7; 3.6]$ does the trajectory change its behaviour and how?

1.2.4 Plotting a famous diagram

Plot a diagram with r on the x axis and the last 50 points of 100 steps long trajectories of a logistic map on the y axis for $2.5 < r < 4$. Use the same initial conditions x_0 for every trajectory.

Tips

- use `scatter!` For the plots. The keyword argument `markersize` determines the size of the scatter points, it should be < 1 here
- If you use any plot inside of a loop, use the `show=true` argument so that your editor really shows the plot