Utrecht University

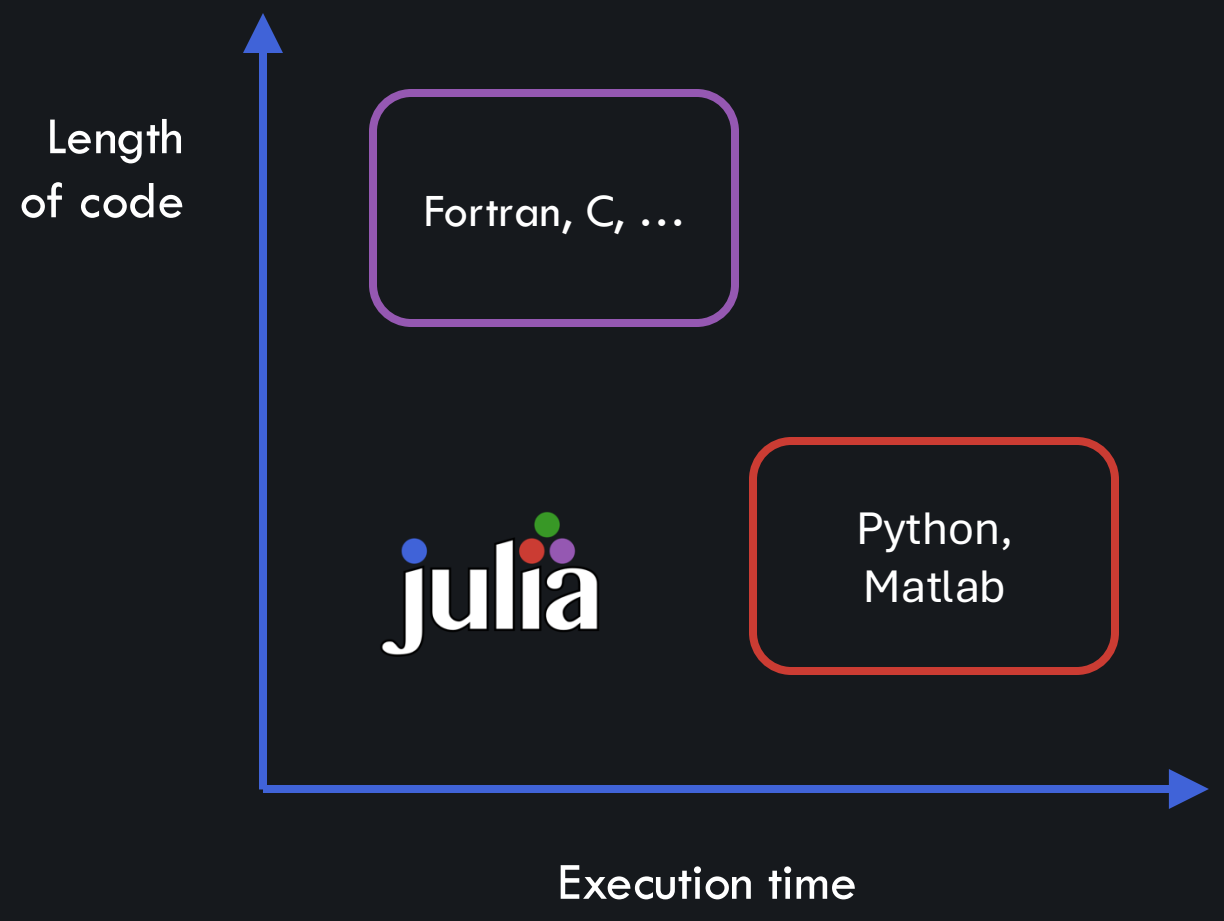
Programming in julia

Tools for dynamical systems and climate

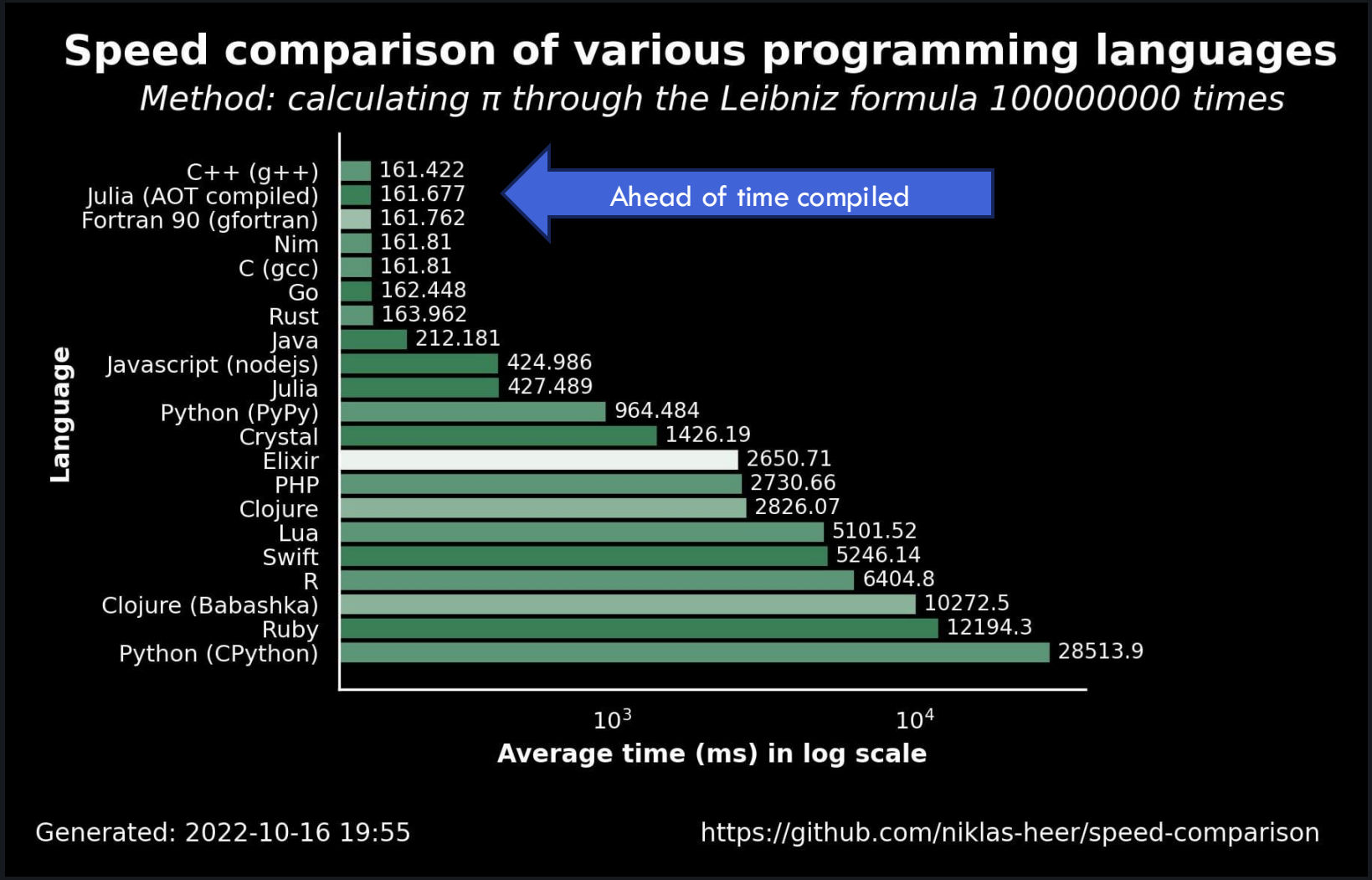
Reyk Börner

Python for Lunch Seminar, 18 September 2025

Two-language problem



Two-language problem



Two-culture problem

Climate scientist

Software engineer

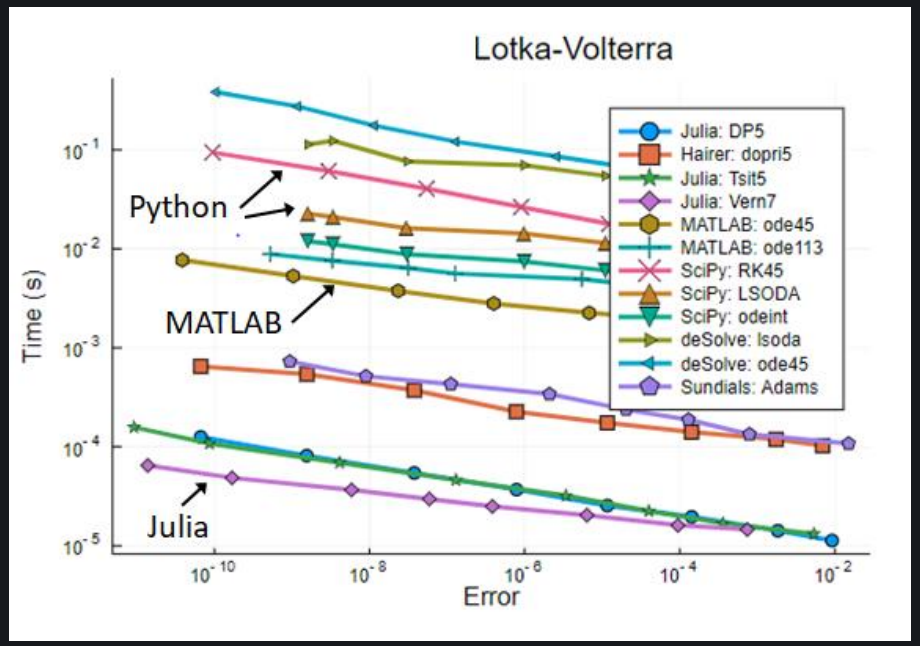
“A typical Julia user is already 90% of the way to a software developer”

What should a good scientific coding language offer?

- Fast to write
- Fast to run
- Composable, clearly structured (easy to read)
- Extendible
- Accessible
- Reproducible

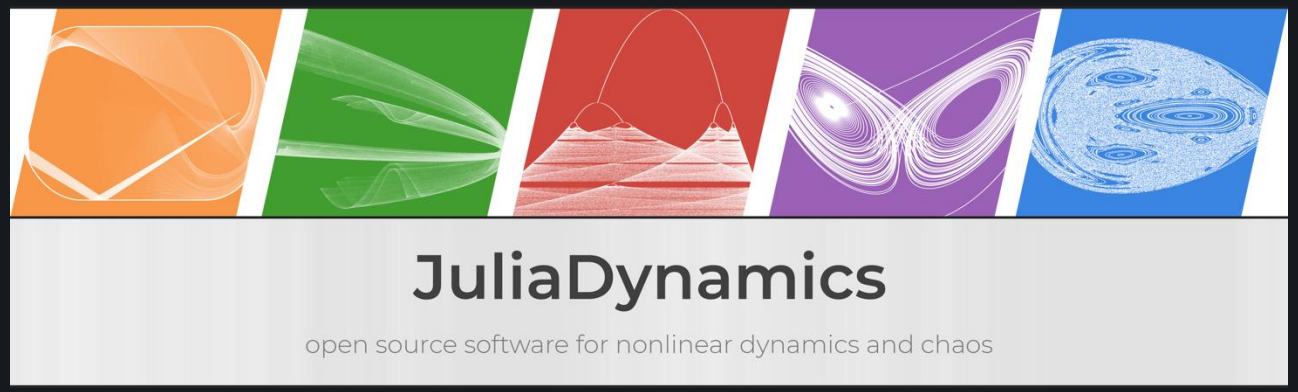
Julia for dynamical systems

- SciML
- DifferentialEquations.jl
- JuliaDynamics
- DynamicalSystems.jl
- BifurcationKit.jl
- CriticalTransitions.jl



Doug Frey

Dynamical Systems.jl



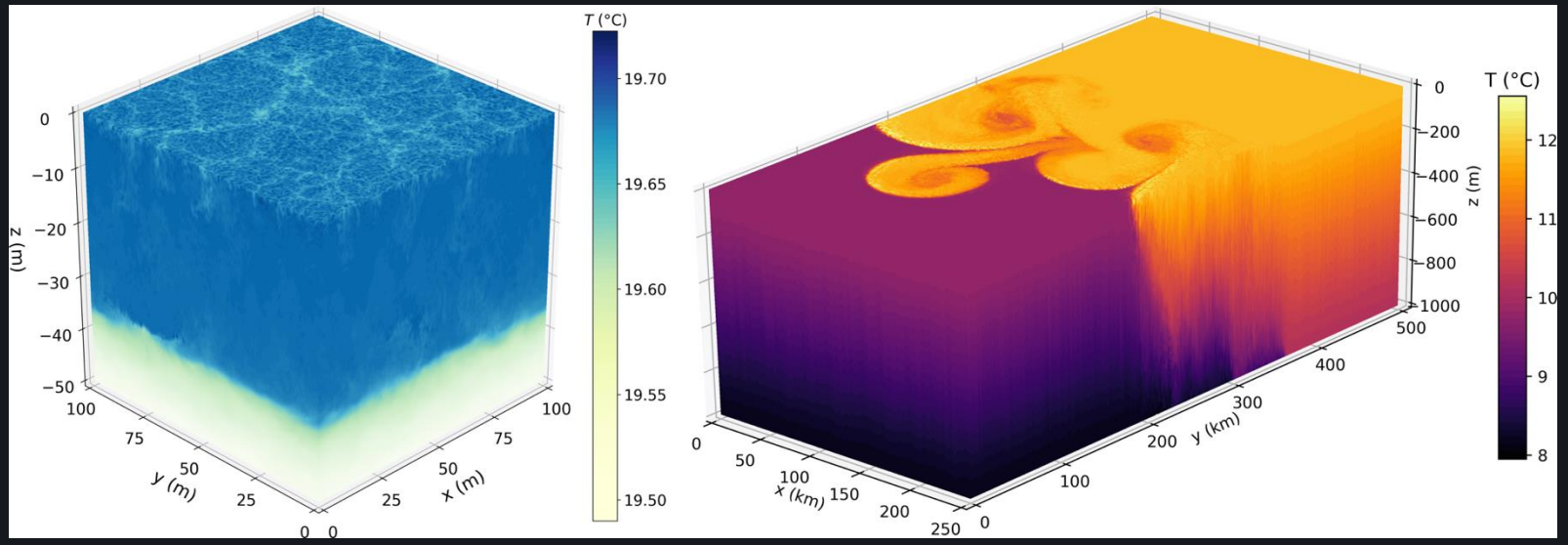
Julia for climate modeling

- CliMA
  - ClimaOcean.jl
  - ClimaAtmos.jl
  - ClimaLand.jl
  - …
- SpeedyWeather.jl
- Oceananigans.jl

CliMA
CLIMATE MODELING ALLIANCE

Oceananigans.jl

🌊 *Fast and friendly fluid dynamics on CPUs and GPUs.*



SpeedyWeather.jl

Writing your own Julia package

… see example: DoubleTrouble.jl

Contributing to DynamicalSystems.jl

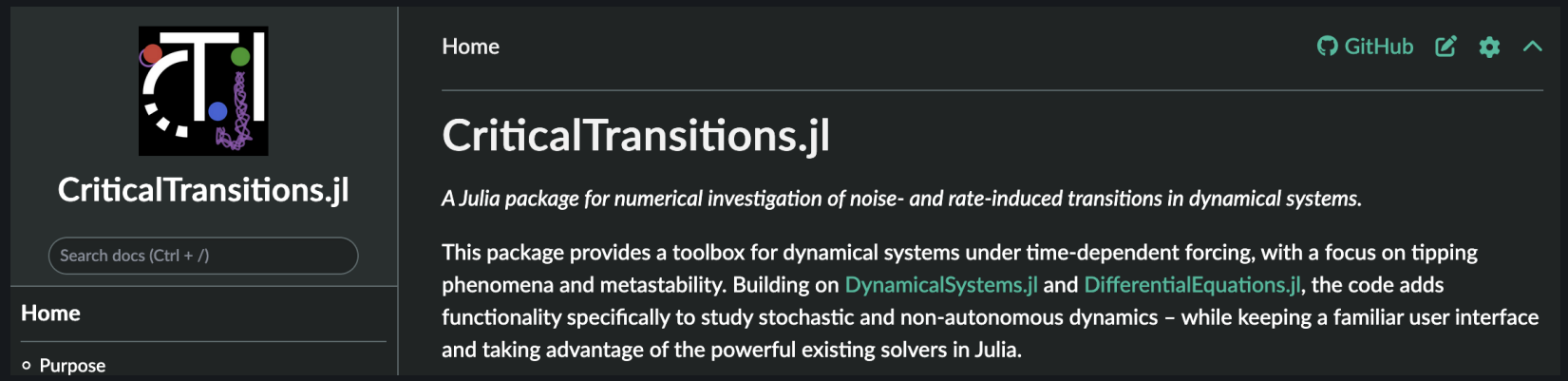
CoupledODEs

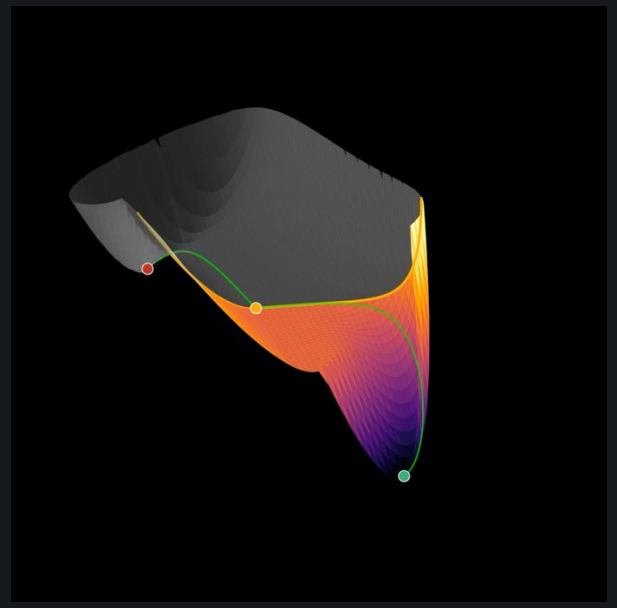
$$\frac{\mathrm{d}\mathbf{u}}{\mathrm{d}t} = \mathbf{f}(\mathbf{u}, p, t)$$

CoupledSDEs

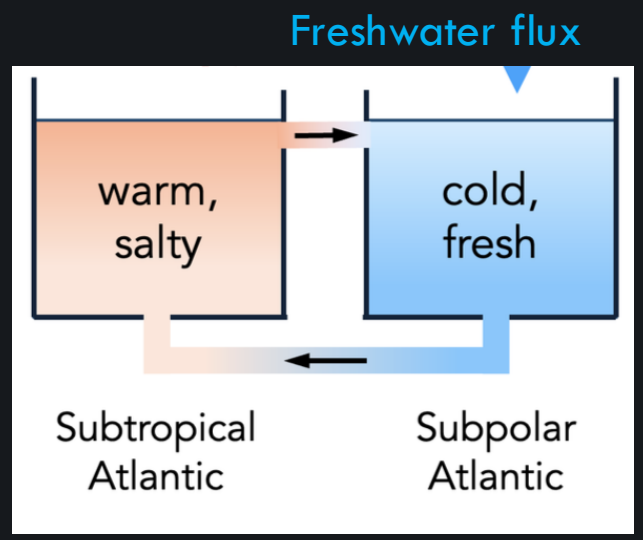
$$\mathrm{d}\mathbf{u} = \mathbf{f}(\mathbf{u}, p, t)\mathrm{d}t + \mathbf{g}(\mathbf{u}, p, t)\mathrm{d}\mathcal{N}_t$$

CriticalTransitions.jl





Example:
Stommel box model
(Stommel 1961)



Resources

- Julia homepage: https://julialang.org
- Juliaup (installer): https://github.com/JuliaLang/juliaup
- Zero2Hero tutorial: https://github.com/Datseris/Zero2Hero-JuliaWorkshop
- Good scientific code workshop: https://github.com/JuliaDynamics/GoodScientificCodeWorkshop

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