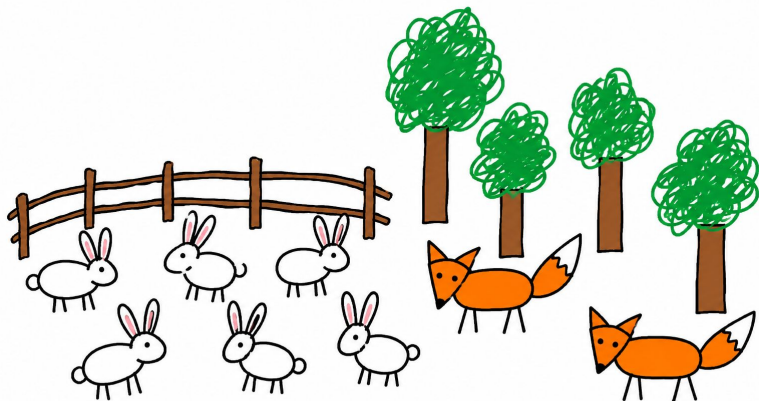


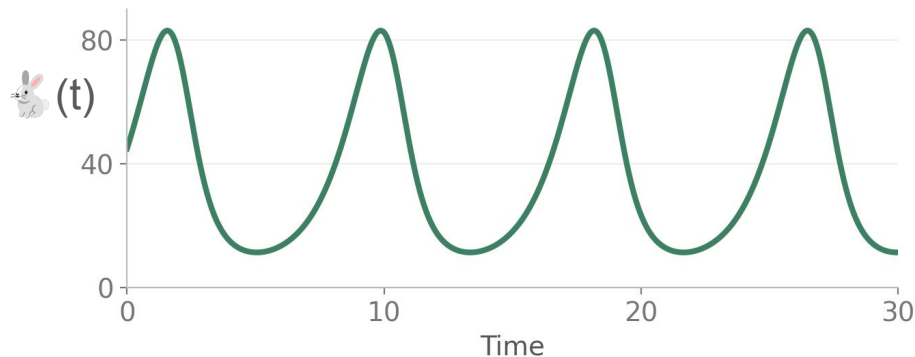
Observable functions of rational ODE models and how to find them

Alexander Demin | LIX & CNRS & Sorbonne Université | [JCC-IB](#), 14 October 2026

Farm & Forest



We count the rabbits



How many foxes live in the forest?

Model with a Lotka-Volterra ODE

Foxes eat rabbits

$$\text{🐰}'(t) = a \text{🐰}(t) - b \text{🐰}(t) \text{🦊}(t)$$

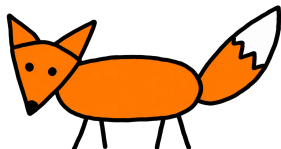
$$\text{🦊}'(t) = c \text{🐰}(t) \text{🦊}(t) - d \text{🦊}(t)$$

- 🐰(t) is **known**
- 🦊(t) is **unknown**
- a,b,c,d are **unknown**

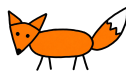
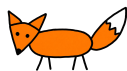
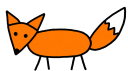
Determine 🦊(t) from the **measured** 🐰(t)?

The count of foxes is not unique

1) one big dangerous fox



2) three less dangerous foxes



Model is **invariant** under

$$\text{fox}(t) \mapsto 3 \text{fox}(t), \quad b \mapsto b/3$$

Foxes eat rabbits

$$\dots - b \text{ rabbit}(t) \text{fox}(t)$$

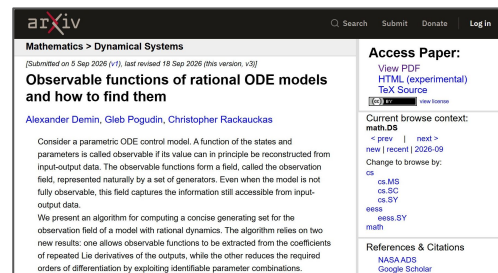
$$- (b/3) \text{ rabbit}(t) (3 \text{fox}(t))$$

$$= - b \text{ rabbit}(t) \text{fox}(t)$$

What *can* we recover from $\text{rabbit}(t)$?

Our algorithm finds such invariants

“Observable functions of rational ODE models and how to find them”



<https://arxiv.org/abs/2609.06134>

Input: a rational ODE model

Output: all functions that can be recovered (*a.k.a. observable functions*)

StructuralIdentifiability.jl

```
julia> ode = @ODEmodel(  
    🐇'(t) = a*🐇(t) - b*🐇(t)*🦊(t),  
    🦊'(t) = c*🐇(t)*🦊(t) - d*🦊(t),  
    y(t) = 🐇(t)  
)  
  
julia> observation_field(ode)
```

Output:

a, c, d, 🐇(t), b*🦊(t)

All recoverable quantities
are combinations of these.

Further questions

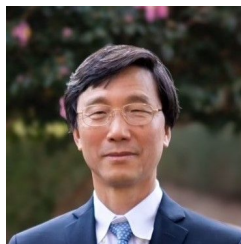
- More **scalable** algorithms?
- Can these algorithms help us build **simpler models**?

Speaker: a new PhD student at LIX and Sorbonne.
We wish to understand these questions...

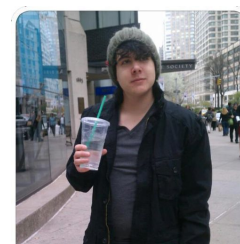
...with my collaborators



Gleb Pogudin (LIX)



Hoon Hong (NC State)



Chris Rackauckas (MIT)

If you have models where such questions arise, we would be happy to chat!