IVS Award 2024 - Doktorarbeit

Polynomial approximation for data-driven system analysis and control of nonlinear systems
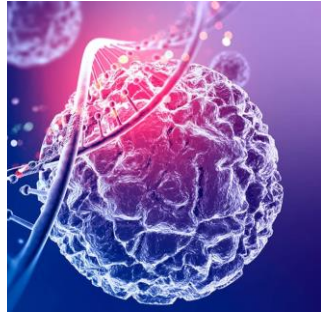
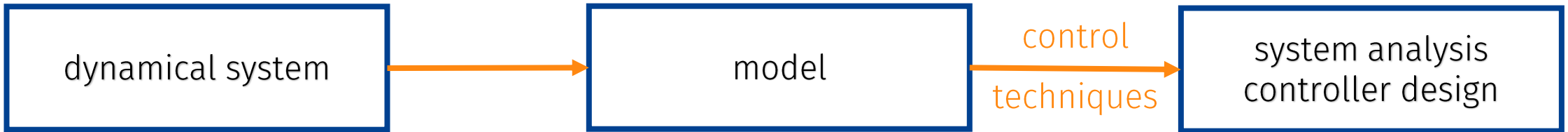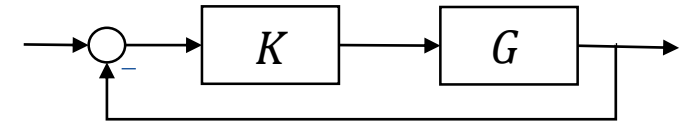## Tim Martin

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Motivation

$$x_{k+1} = f(x_k, u_k)$$

| dynamical system | → | model | control techniques → | system analysis controller design |

classical: first principles
- time consuming
- expert knowledge

data-based: measured trajectories
- easily available
- no guarantees
- unpredictable

- nonconvex optimization

Main result of the thesis

noisy data →(*polynomial approximation*)→ **system representation** →(*convex optimization*)→ system properties controller
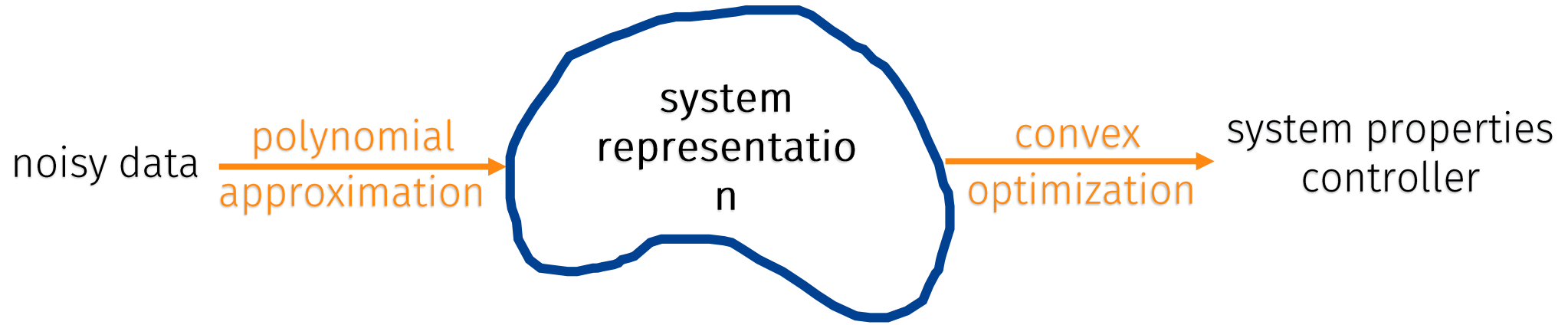
Data-based system representation for *nonlinear systems* tailored for
- ... with mathematically *rigorous guarantees*
- ... relying on *convex optimization*

Polynomial data-based system representation
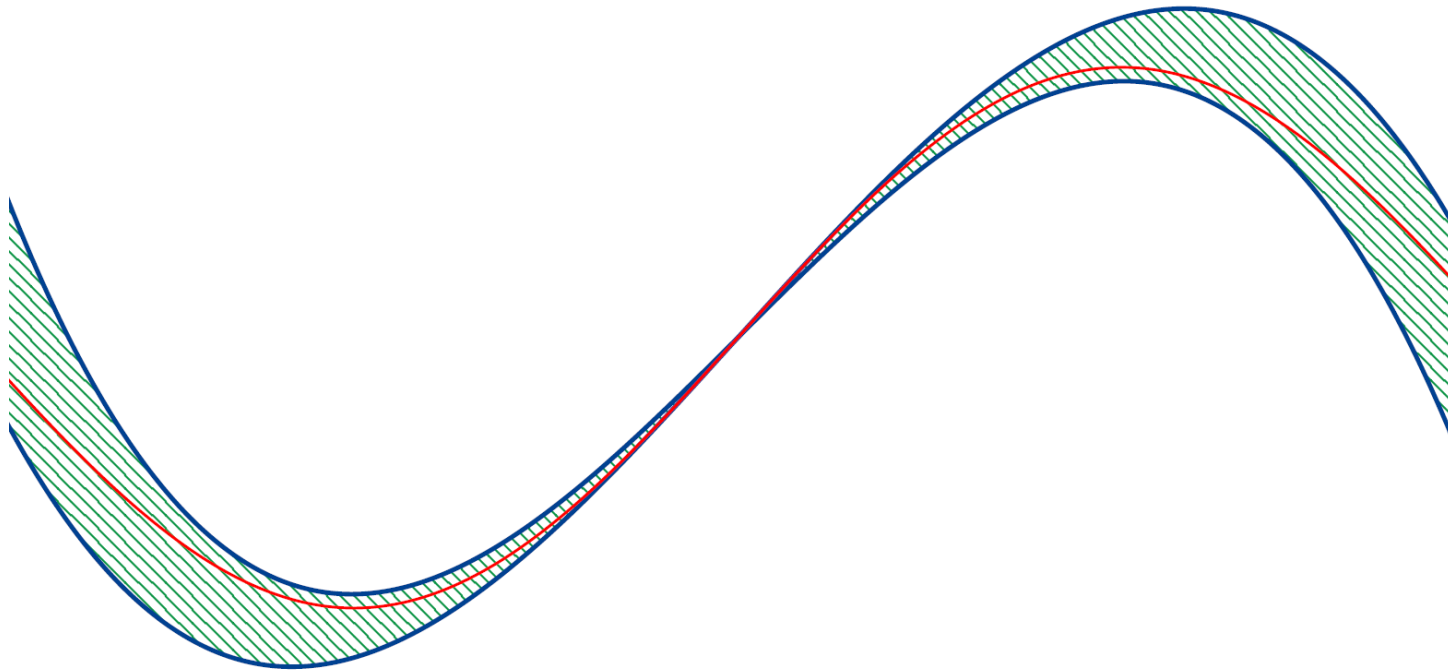
Data $\{x_k, u_k\}_{k=1}^S$ satisfying

$$x_{k+1} = f(x_k, u_k) + d_k$$

Polynomial sector including nonlinear unknown function

- exploit *approximation error* from literature

- infer *set of polynomials* from data including interpolation polynomial