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HOCHSCHULE KOBLENZ
UNIVERSITY OF APPLIED SCIENCES

AMLS
ANWENDUNGSZENTRUM FÜR MASCHINELLES LERNEN UND SENSORTECHNOLOGIE

UNIVERSITÄT **BONN**

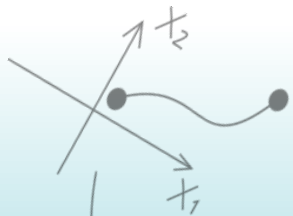# Structural Error Estimation in Dynamic Systems

Dominik Kahl, Philipp Wendlandt
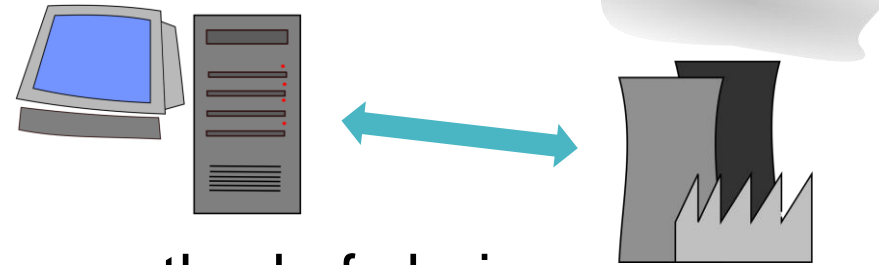## Andreas Weber, Maik Kschischo

18.09.2018

- SEEDS is supported by Deutsche Forschungsgesellschaft
  Project - Nr. 354645666

- SEEDS contains a PhD-Project in coorperation with University Bonn

  Supervised by   Andreas Weber (Bonn)
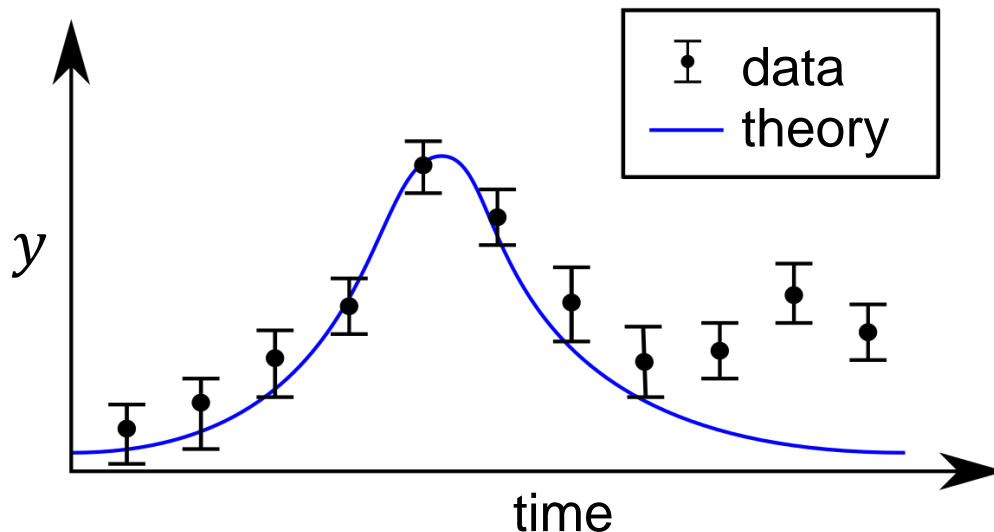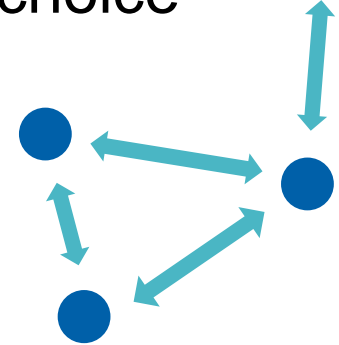   and   Maik Kschischo (Koblenz)

Dynamic Systems

Biology, Pharmacy, Physics …

 Dynamic Systems are the method of choice

$$\begin{cases} \dot{x} = f(x, u) & \textit{(Dynamic Equation)} \\ y = h(x) & \textit{(Observation)} \end{cases}$$

data
theory

y

time

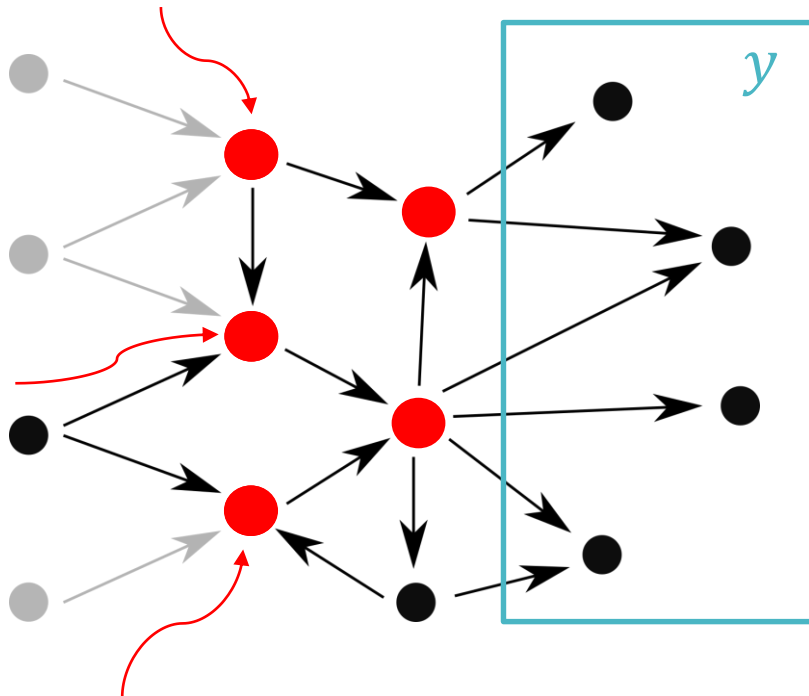Experts are needed to improve the model

Models can reach

100 - 1000 dimensions

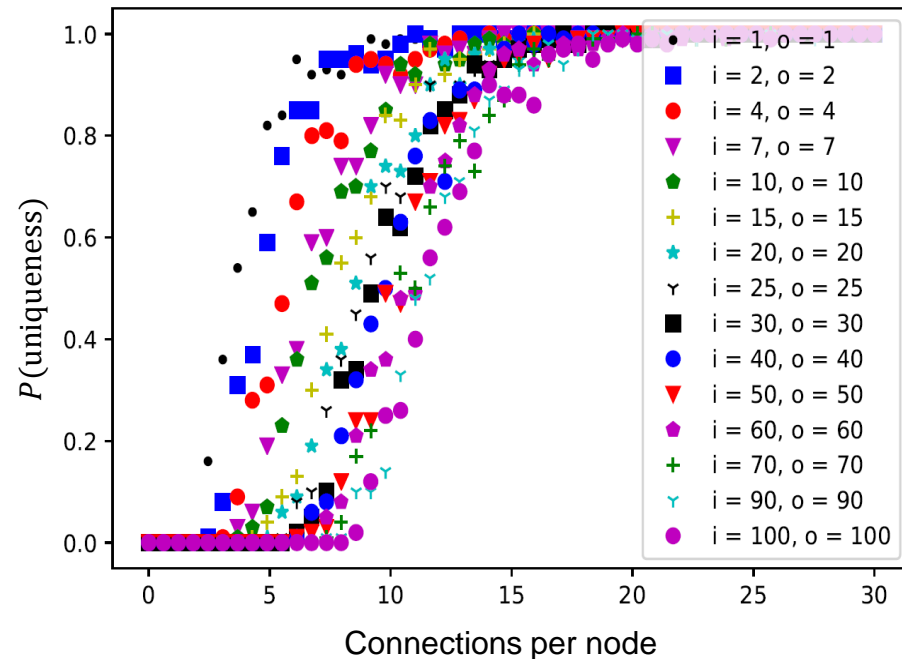# Error Detectability Criteria

Is it possible to identify the model error?

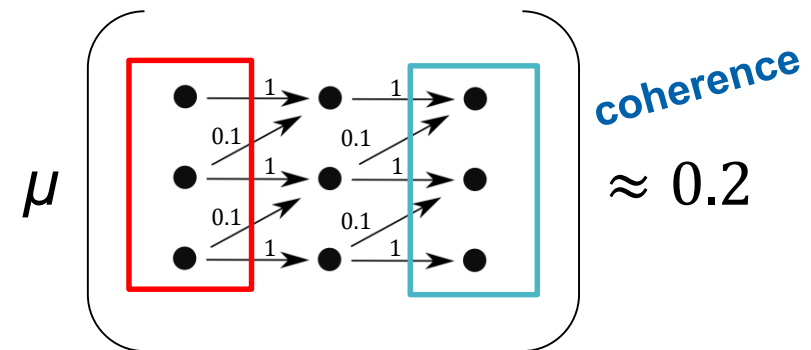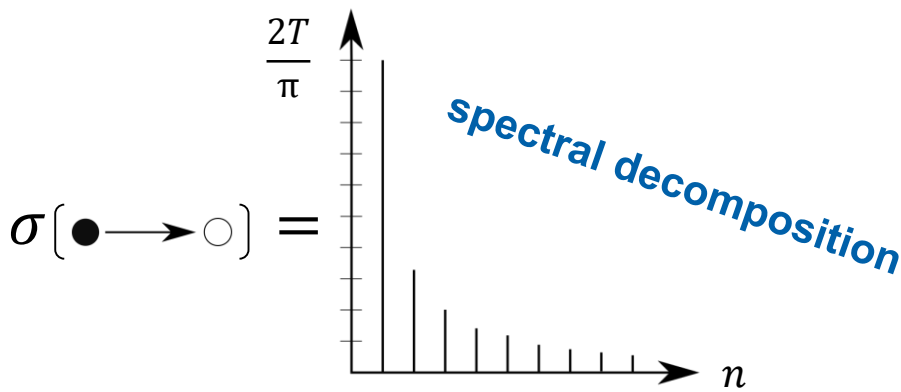➡️ Analytical and graphical criteria

running in polynomial time

Phase transition in homogeneous networks

Compressed Error Sensing

Static Compressed Sensing

led to remarkable results.

We extend it to dynamic

systems …

guarantees uniqueness

$$\text{spark} \begin{pmatrix} \end{pmatrix} = 2$$

with y highlighted in the matrix diagram

spectral decomposition

$$\sigma[\bullet \longrightarrow \circ] =$$

with $\frac{2T}{\pi}$ axis and n axis

coherence

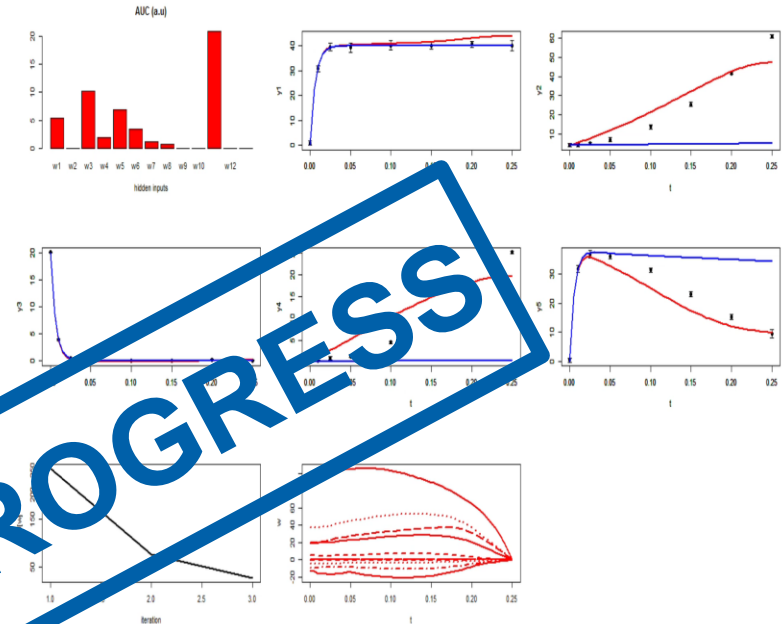$$\mu \begin{pmatrix} \end{pmatrix} \approx 0.2$$
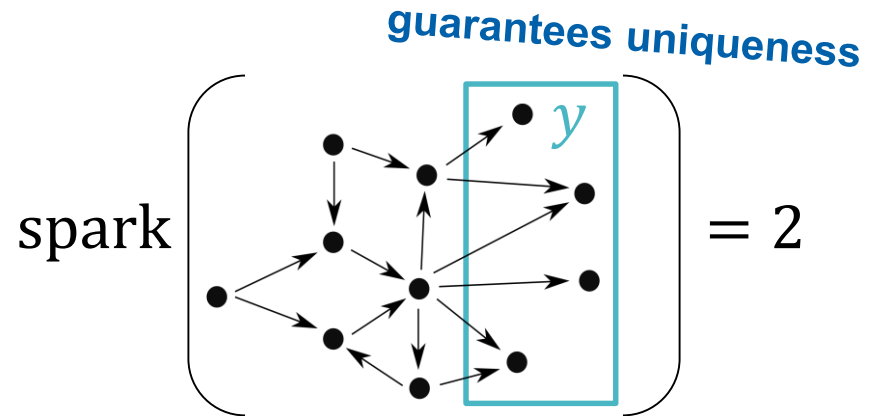
Future Prospects

Dynamic Elastic Net [1]

Optimization procedure to find model errors

Bio - Networks

Did evolution optimize network topology?

Theory of dynamic compressed sensing

Sensor placement

Experimental Design

WORK IN PROGRESS

SEEDS

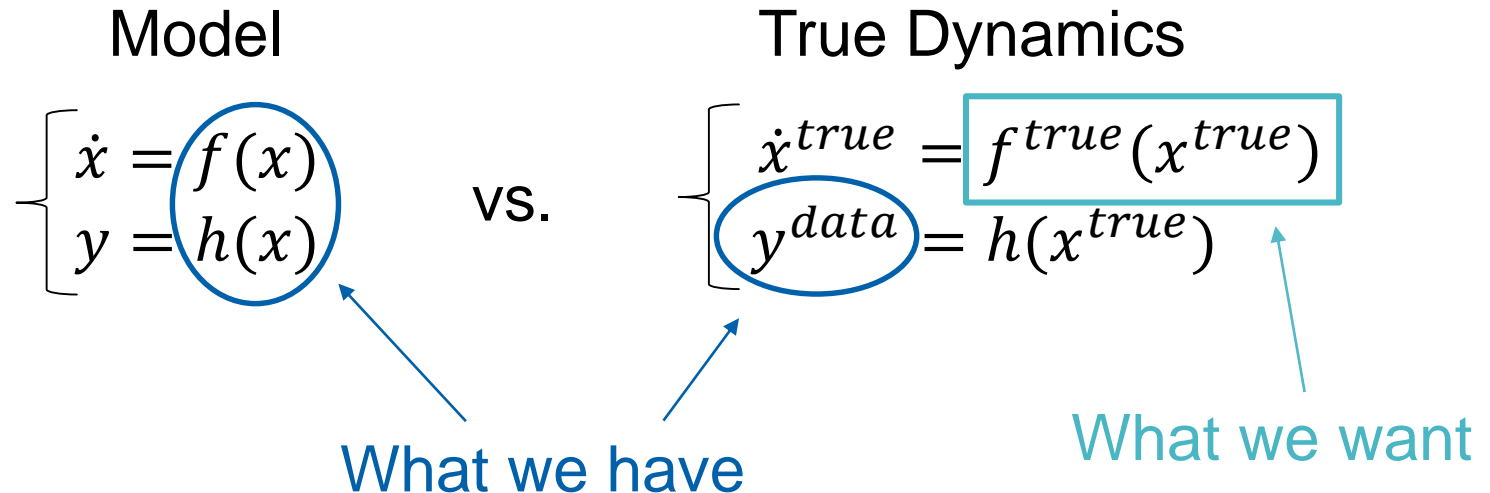# Structural Error Estimation in Dynamic Systems

Thank you for your attention

Literature

[1] Benjamin Engelhardt, Holger Fröhlich, and Maik
Kschischo. *Learning (from) the errors of a systems biology
model.* Scientic Reports, 6, November 2016.

Structural Error Estimation

Model

True Dynamics

$$\begin{cases} \dot{x} = f(x) \\ y = h(x) \end{cases}$$

vs.

$$\begin{cases} \dot{x}^{true} = f^{true}(x^{true}) \\ y^{data} = h(x^{true}) \end{cases}$$

What we have

What we want

Correct the model with a hidden input w

$$\dot{\hat{x}} = f(\hat{x}) + w \qquad \text{to get} \qquad y^{data} = h(\hat{x})$$

Does w exist and is it unique?