



Friedrich-Alexander-Universität  
Research Center for  
Mathematics of Data | MoD

## FAU MoD Workshop



**Giovanni Fantuzzi**

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ERLANGEN-NÜRNBERG

### **Lyapunov meets Koopman: A new approach to data-driven analysis of nonlinear dynamics**

Lyapunov frameworks have been used for decades to analyze the performance of nonlinear dynamical systems with known mathematical models.

The Koopman operator framework has instead recently gained popularity for studying nonlinear dynamics from data.

This talk will explain how these two frameworks can be unified into a groundbreaking data-driven Koopman-Lyapunov approach for analyzing nonlinear dynamics, which can answer a much wider range of dynamical systems questions compared to classical Koopman methods alone.

I will also discuss perspectives and open challenges related to the implementation and mathematical analysis of this Koopman-Lyapunov approach.

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**Denisa Martonová**

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### **Data-driven constitutive modeling for soft biological tissues**

An accurate description of mechanical behavior in biological tissues relies on the formulation of suitable constitutive models. This talk will explain how data-driven approaches can automate the discovery of such models directly from experimental measurements. We introduce invariant-based and principal-stretch-based constitutive neural networks that embed physical constraints and recover interpretable formulations for hyperelastic materials. We then extend this concept to generalized-invariant-based constitutive neural networks, which simultaneously learn both the invariant representation and the underlying model. Finally, we outline a complementary database-driven method that bypasses numerical optimization and rapidly identifies constitutive behavior through pattern recognition. Together, these approaches illustrate how automated, physics-embedded model discovery can enhance modeling in biomechanics and beyond.

### WHEN

Wednesday  
**December 10, 2025**

11:30H  
(Berlin time)

### WHERE

On-site / Online

FAU  
Friedrich-Alexander-  
Universität  
Erlangen-Nürnberg  
**Room H21**  
ER – Südgelände.  
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Live streaming:  
[www.fau.tv/clip/id/59621](http://www.fau.tv/clip/id/59621)