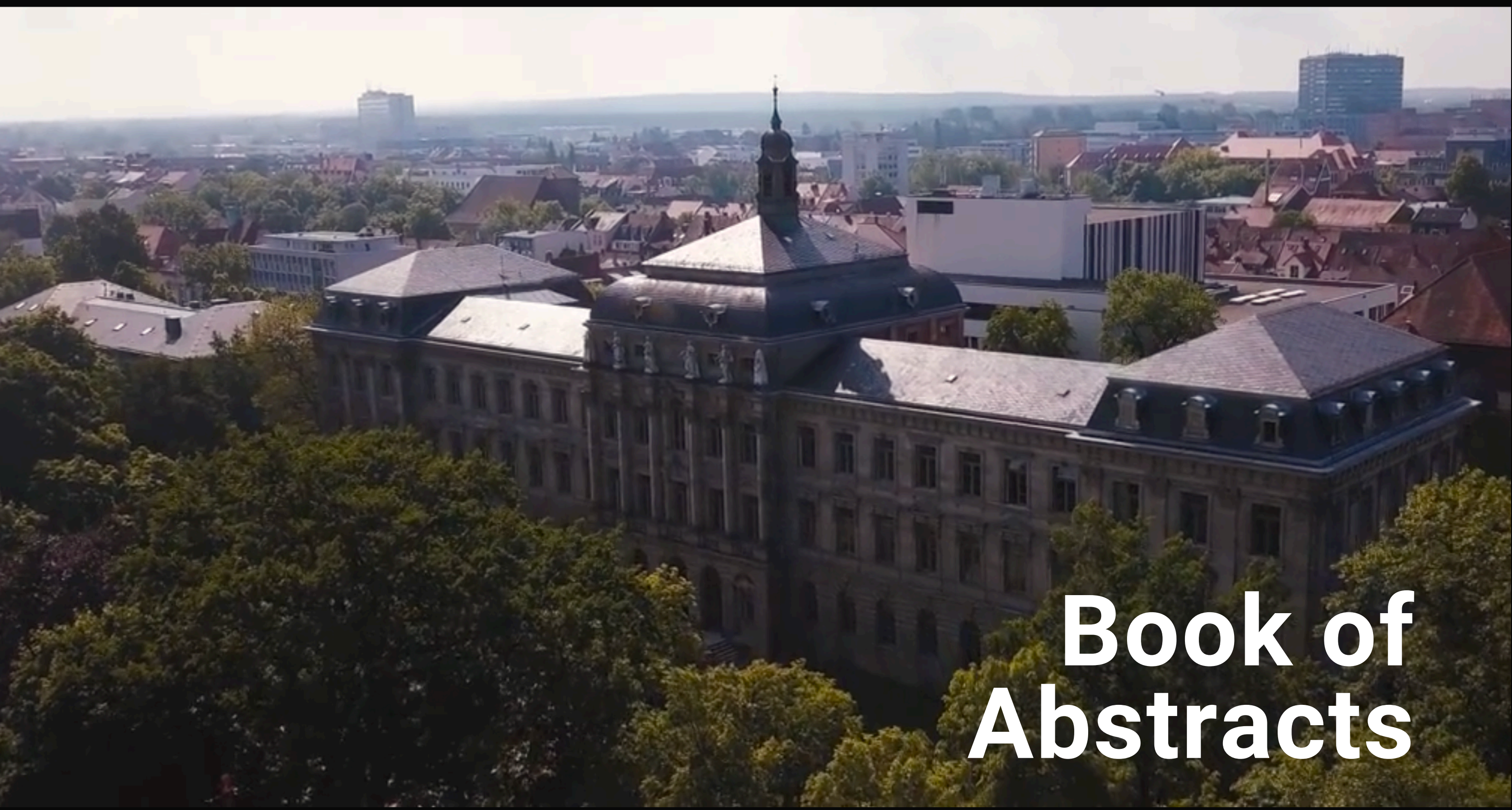
Machine Learning and PDEs

#MLPDES26 WORKSHOP

June 22 - 24, 2026

ERLANGEN, BAVARIA • ONLINE



Book of Abstracts

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

UNTERSTÜTZT VON / SUPPORTED BY

Alexander von HUMBOLDT STIFTUNG

Friedrich-Alexander-Universität
DYNAMICS, CONTROL, MACHINE LEARNING AND NUMERICS

Politecnico di Bari

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MLPDES26

MACHINE LEARNING AND PDES
WORKSHOP 2026

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Organizing Committee

ERLANGEN • ONLINE | JUNE 22-24, 2026

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MLPDES26 Scientific Committee's Note

Hosted by FAU MoD at Friedrich-Alexander-Universität Erlangen-Nürnberg in Germany, the **#MLPDES26 workshop** is the second edition of an international event that brings together researchers from Europe, UK, China and the United States to explore the growing connection between Machine Learning (ML) and Partial Differential Equations (PDEs) —two core fields in modern mathematics that are now developing a dynamic, mutually beneficial relationship.

Supported by the FAU DCN-AvH, Chair for Dynamics, Control, Machine Learning and Numerics - Alexander von Humboldt Professorship, Politecnico di Bari and the Alexander von Humboldt Foundation, this event aims to establish a collaborative platform for participants from diverse backgrounds to network, sharing insights, and driving progress in these exciting fields.
Join us as we bridge these fields, focusing on both foundational research and practical applications.

See you in Erlangen & Online!

Giuseppe Maria Coclite
Politecnico di Bari

Enrique Zuazua
FAU MoD • FAU DCN-AvH
Alexander von Humbold Professor
Friedrich-Alexander-Universität
Erlangen-Nürnberg

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MLPDES26

MACHINE LEARNING AND PDES WORKSHOP 2026

Invited Speakers

ERLANGEN • ONLINE | JUNE 22-24, 2026

BOOK OF ABSTRACTS

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

Hosted by FAU MoD at Friedrich-Alexander-Universität Erlangen-Nürnberg, the **#MLPDES26 workshop** is the second edition of an international event that brings together researchers from Europe, UK and the United States to explore the growing connection between Machine Learning (ML) and Partial Differential Equations (PDEs) —two core fields in modern mathematics that are now developing a dynamic, mutually beneficial relationship.

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PoliTO	UAM | FAU	GMU	Unipi	Oxford	Unipi	EPFL	NTNU	Unipd
Riccardo Adami	Antonio Alvarez	Harbir Antil	Luigi Berselli	Maria Bruna	Giuseppe Buttazzo	Gonzalo Cao-Labora	Elena Celledoni	Annalisa Cesaroni

Machine Learning and PDEs

#MLPDES26 WORKSHOP

June 22 - 24, 2026

ERLANGEN - BAVARIA, GERMANY

Ulrik Skre Fjordholm	Ingenuin Gasser	Sam G. Krupa	Xue-Mei Li	Francesco Maddalena	Jean-Michel Morel	Lorenzo Pareschi	Emil Wiedemann	Yanzhi Wu
UIO	Uni-Hamburg	ENS-PSL	EPFL	Poliba	Lingnan	HW | Unife	FAU	FAU

WHEN

Mon.-Wed. **June 22 - 24, 2026**
09:30H - 17:00H

WHERE

On-site. FAU, Friedrich-Alexander-Universität Erlangen-Nürnberg
Senatssaal (Senate Hall) im Kollegienhaus
Universitätsstraße 15, 91054 Erlangen - Bavaria, Germany

Online (live streaming): **fau.tv/clip/id/63196**

REGISTRATION

Free but mandatory
Registration form: **dcn.nat.fau.eu/registration-mlpdes26**

SCIENTIFIC COMMITTEE

- **Giuseppe Maria Coclite.** Politecnico di Bari
- **Enrique Zuazua.** FAU, Friedrich-Alexander-Universität Erlangen-Nürnberg

ORGANIZING COMMITTEE

- **Darlis Bracho Tudares.** FAU, Friedrich-Alexander-Universität Erlangen-Nürnberg
- **Nicola De Nitti.** Università di Pisa
- **Lorenzo Liverani.** FAU, Friedrich-Alexander-Universität Erlangen-Nürnberg

AUDIENCE

This international workshop is open to: Public, Students, Postdocs, Professors, Faculty, Alumni and the scientific community all around the world

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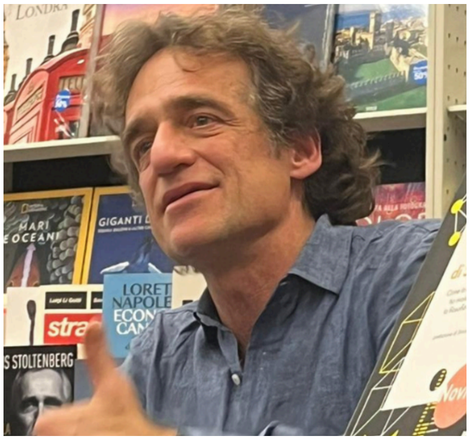
UNTERSTÜTZT VON / SUPPORTED BY

Alexander von HUMBOLDT STIFTUNG

Friedrich-Alexander-Universität
DYNAMICS, CONTROL, MACHINE LEARNING AND NUMERICS

Politecnico di Bari

Invited Speakers



Riccardo Adami

PoliTO, Politecnico di Torino

Antonio Alvarez López

UAM, Autonomous University of Madrid and FAU, Friedrich-Alexander-Universität Erlangen-Nürnberg

Harbir Antil

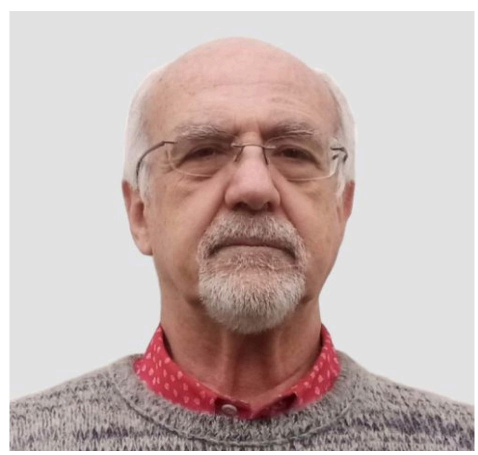
GMU, George Mason University

Luigi Berselli

Unipi, University of Pisa

Maria Bruna

University of Oxford



Giuseppe Buttazzo

Unipi, University of Pisa

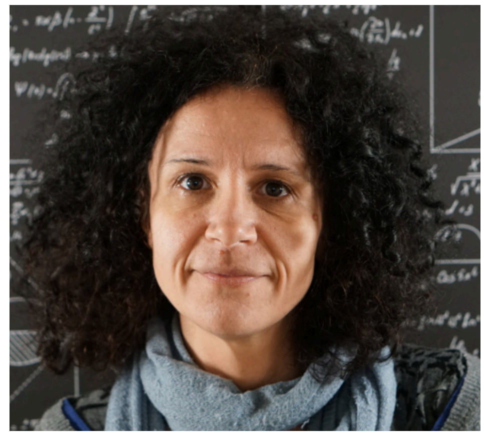
Invited Speakers

Gonzalo Cao Labora

EPFL, École Polytechnique Fédérale de Lausanne

Elena Celledoni

NTNU, Norwegian University of Science and Technology



Annalisa Cesaroni

Unipd, Università degli Studi di Padova

Ulrik Skre Fjordholm

University of Oslo

Ingenuin Gasser

Universität Hamburg

Sam G. Krupa

ENS Paris, École Normale Supérieure – PSL

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BAVARIA, GERMANY

Invited Speakers

Xue-Mei Li

EPFL, École Polytechnique Fédérale de Lausanne

Francesco Maddalena

Poliba, Politecnico di Bari

Jean-Michel Morel

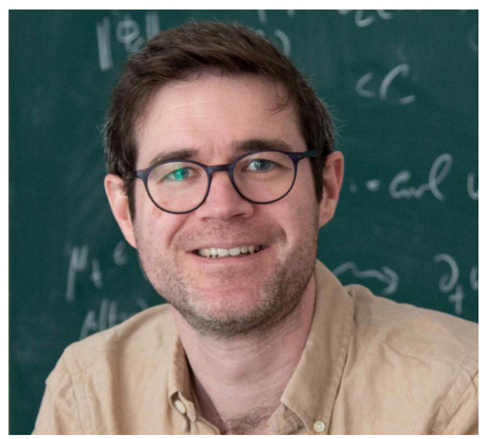
Lingnan University

Lorenzo Pareschi

Heriot Watt University and Università degli studi di Ferrara

Yanzhi Wu

FAU DCN-AvH, Friedrich-Alexander-Universität Erlangen-Nürnberg



Emil Wiedemann

FAU, Friedrich-Alexander-Universität Erlangen-Nürnberg

Program

ERLANGEN • ONLINE | JUNE 22-24, 2026

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Friedrich-Alexander-Universität
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June 22 - 24, 2026

ONLINE • ERLANGEN
BAVARIA, GERMANY

#MLPDES26 Schedule • Time table

	MON. JUNE 22, 2026	TUE. JUNE 23, 2026	WED. JUNE 24, 2026
09:20H 09:50H	Registration **Opening ceremony**	Maria Bruna. **Oxford** Microscopic interactions and macroscopic PDEs: Beyond the mean-field paradigm	Emil Wiedemann. **FAU** Beyond Incompatibility: Using Optimal Transport for Algorithmic Fairness
10:00H 10:30H	Giuseppe Buttazzo. **Unipi** Optimal data for elliptic PDEs	Harbir Antil. **GMU** Digital Twins and Beyond: A PDE-Constrained Optimization Perspective	Sam G. Krupa. **ENS-PSL** Are L^∞ solutions to hyperbolic systems of conservation laws unique?
10:40H	COFFEE / TEA BREAK		
11:10H 11:40H	Elena Celledoni. **NTNU** Structure preservation and Deep Learning for Learning Mechanical Systems from Data	Ulrik Fjordholm. **UIO** The zero-noise limit for hyperbolic conservation laws	Yanzhi Wu. **FAU DCN-AvH** Data-Driven control of unknown linear systems: Two disturbance models
11:50H 12:20H	Xue-Mei Li. **EPFL** Rough PDEs, Long-Range Dependence, and Multi-Scale Dynamics	Riccardo Adami. **PoliTO** A mathematical model for the Einstein-Podolsky-Rosen phenomenon	Luigi Berselli. **Unipi** Womersley type flows for a non Newtonian fluid with variable exponent
12:30H	LUNCH BREAK		Annalisa Cesaroni. **Unipd** Analysis of commuting times in a linear city
14:00H 14:30H	Ingenuin Gasser. **Uni-Hamburg** Mathematical models in the context of renewable energies	Lorenzo Pareschi. **HW | Unife** Structure-Preserving Neural Surrogates for Uncertainty Quantification in Plasma Physics	**Closing ceremony**
14:40H 15:10H	Gonzalo Cao-Labora. **EPFL** Discovery of unstable singularities	Francesco Maddalena. **Poliba** Multiple Scales in a Nonlocal Evolution Equation of Continuum Mechanics	
15:20H 16:00H	Jean-Michel Morel. **Lingnan University.** On Interpolation Formulas Describing Neural Network Generalization	Antonio Alvarez. **UAM | FAU** Perceptrons and localization of attention's mean-field landscape	

SCIENTIFIC COMMITTEE

Giuseppe Maria Coclite. **Poliba**
Enrique Zuazua. **FAU**

ORGANIZING COMMITTEE

Darlis Bracho Tudares. **FAU**
Nicola De Nitti. **UniPi**
Lorenzo Liverani. **FAU**

WHERE

Onsite. **FAU.** Senate Hall. Kollegienhaus.
Universitätsstraße 15, 91054 Erlangen
Online (live-streaming): **fau.tv/clip/id/63196**

23.06.2026

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Machine Learning and PDEs

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June 22 - 24, 2026

ONLINE • ERLANGEN
BAVARIA, GERMANY

Program DAY 1 • Mon. June 22, 2026

09:20H

Registration
Opening ceremony

10:00H
10:30H

Giuseppe Buttazzo
Unipi, University of Pisa
Optimal data for elliptic PDEs

10:40H

COFFEE / TEA BREAK

11:10H
11:40H

Elena Celledoni
NTNU, Norwegian University of Science and Technology
Structure preservation and Deep Learning for Learning Mechanical Systems from Data

11:50H
12:20H

Xue-Mei Li
EPFL, École Polytechnique Fédérale de Lausanne
Rough PDEs, Long-Range Dependence, and Multi-Scale Dynamics

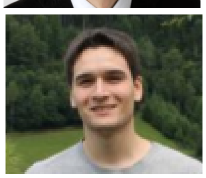
12:30H

LUNCH BREAK

14:00H
14:30H

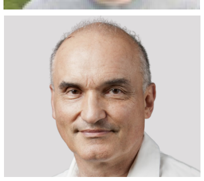
Ingenuin Gasser
Universität Hamburg
Mathematical models in the context of renewable energies

14:40H
15:10H



Gonzalo Cao Labora
EPFL, École Polytechnique Fédérale de Lausanne
Discovery of unstable singularities

15:20H
16:00H



Jean-Michel Morel
Lingnan University
On Interpolation Formulas Describing Neural Network Generalization

SCIENTIFIC COMMITTEE

Giuseppe Maria Coclite. **Poliba**
Enrique Zuazua. **FAU**

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Nicola De Nitti. **UniPi**
Lorenzo Liverani. **FAU**

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BAVARIA, GERMANY

Program DAY 2 • Tue. June 23, 2026

09:20H – 09:50H

Maria Bruna
University of Oxford
Microscopic interactions and macroscopic PDEs: beyond the mean-field paradigm

10:00H – 10:30H

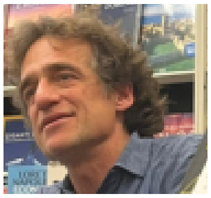
Harbir Antil
GMU, George Mason University
Digital Twins and Beyond: A PDE-Constrained Optimization Perspective

10:40H — **COFFEE / TEA BREAK**

11:10H – 11:40H

Ulrik Skre Fjordholm
University of Oslo
The zero-noise limit for hyperbolic conservation laws

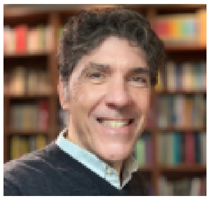
11:50H – 12:20H



Riccardo Adami
PoliTO, Politecnico di Torino
A mathematical model for the Einstein-Podolsky-Rosen phenomenon

12:30H — **LUNCH BREAK**

14:00H – 14:30H



Lorenzo Pareschi
Heriot Watt University and Università degli studi di Ferrara
Structure-Preserving Neural Surrogates for Uncertainty Quantification in Plasma Physics

14:40H – 15:10H

Francesco Maddalena
Poliba, Politecnico di Bari
Multiple Scales in a Nonlocal Evolution Equation of Continuum Mechanics

15:20H – 16:00H

Antonio Alvarez
UAM, Autonomous University of Madrid and FAU, Friedrich-Alexander-Universität Erlangen-Nürnberg
Perceptrons and localization of attention's mean-field landscape

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Machine Learning and PDEs

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June 22 - 24, 2026

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Program DAY 3 • Wed. June 24, 2026

09:20H
09:50H

Emil Wiedemann
FAU, Friedrich-Alexander-Universität Erlangen-Nürnberg
Beyond Incompatibility: Using Optimal Transport for Algorithmic Fairness

10:00H
10:30H

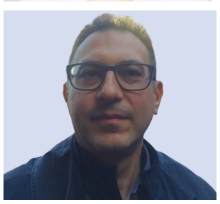
Sam G. Krupa
ENS Paris, École Normale Supérieure – PSL
Are L^∞ solutions to hyperbolic systems of conservation laws unique?

10:40H **COFFEE / TEA BREAK**

11:10H
11:40H

Yanzhi Wu
FAU DCN-AvH. Friedrich-Alexander-Universität Erlangen-Nürnberg
Data-Driven Control of Unknown Linear Systems: Two Disturbance Models

11:50H
12:20H



Luigi Berselli
Unipi, University of Pisa
Womersley type flows for a non Newtonian fluid with variable exponent

12:30H **LUNCH BREAK**

14:00H
14:30H

Annalisa Cesaroni
Unipd, Università degli Studi di Padova
Analysis of commuting times in a linear city

14:40H **CLOSING CEREMONY**

SCIENTIFIC COMMITTEE

Giuseppe Maria Coclite. **Poliba**
Enrique Zuazua. **FAU**

ORGANIZING COMMITTEE

Darlis Bracho Tudares. **FAU**
Nicola De Nitti. **UniPi**
Lorenzo Liverani. **FAU**

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MACHINE LEARNING AND PDES
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Abstracts

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BOOK OF ABSTRACTS

Abstracts

Giuseppe Buttazzo **Unipi, University of Pisa**

Optimal data for elliptic PDEs

The goal is to present some optimization problems related to an elliptic PDE, where the control variables are the data of the equation. The cases we consider are the following.
• The PDE is of the form $-{\rm div}(a(x)\nabla u)=f$ and the control is the coefficient a;
• The PDE is of the form $-\Delta u+V(x)u=f$ and the control is the potential V;
• The PDE is of the form $-\Delta u=f$ and the control is the right-hand side f.
In all the cases the boundary conditions are of Dirichlet type, and the cost functional is an integral like J(u)=\int_\Omega j(x,u,\nabla u)\,dx. The admissible controls are constrained to satisfy an integral condition as \int_\Omega\psi(a)\,dx\le m,\qquad\int_\Omega\psi(V)\,dx\le m, \qquad \int_\Omega\psi(f) \,dx\le m respectively. The goal is to obtain, under suitable assumptions on the functions j and ψ, the existence of optimal controls. The results are in a series of works in collaboration with J. Casado-Díaz and F. Maestre, from Universidad de Sevilla.

Elena Celledoni **NTNU, Norwegian University of Science and Technology**

Structure preservation and Deep Learning for Learning Mechanical Systems from Data

In this talk I will review work on the analysis of motion capturing data and similar applications using techniques of shape analysis and deep learning. I will then consider a method for learning the Lagrangian and forces for mechanical systems using the discrete Lagrange d'Alembert principle. The case of manifold valued data and data on Lie groups will also be discussed if time permits. Applications to mechanical system will be considered.

Xue-Mei Li **EPFL, École Polytechnique Fédérale de Lausanne**

Rough PDEs, Long-Range Dependence, and Multi-Scale Dynamics

I will discuss the role of long-range dependence and multiple time scales in partial differential equations. In particular, I will focus on stochastic dynamics driven by long-range dependent noise. Whether machine learning can contribute to the understanding of such systems, especially in the presence of multiple time scales, remains an open and intriguing question.

Abstracts

Ingenuin Gasser Universität Hamburg

Mathematical models in the context of renewable energies

The presentation refers to the mathematical modelling of power plants based on renewable resources, ranging from established applications such as parabolic trough power plants to osmotic pressure driven energy conversion technologies. The complexity of such applications requires a substantial mathematical modelling effort to finally end up with reasonable models, which can be simulated fast and robust and which allow optimisation approaches. All applications involve fluid dynamic or thermo-fluid dynamic models which have to be significantly reduced under the restriction of keeping the most relevant chemical, bio-chemical and physical effects. Mathematically these models mostly are nonlinear systems of ODEs or PDEs of mixed elliptic-hyperbolic type. We present the most recent results on some of the models. In view of the underlying application we discuss which quantities are reasonable to be optimized, e.g. the power output of the power plant with respect to operational or system parameters.

Gonzalo Cao Labora EPFL, École Polytechnique Fédérale de Lausanne

Discovery of unstable singularities

I will present a new method based on physics-informed neural networks that allows us to discover singularities in fluid PDEs. Our setting focuses on self-similar solutions—those that evolve in time solely through horizontal and vertical rescalings. In this framework, the problem of finding singularities reduces to a PDE without initial data nor time dependence, and the central challenge becomes determining if any smooth solutions to this equation exist. We will see how neural networks are able to efficiently explore the space of functions to find these solutions. This is particularly valuable in the case of unstable solutions, where traditional numerical methods often struggle. Specifically, I will present the discovery of new solutions for the incompressible porous media equation, the Euler equations with boundary, and the Cordoba-Cordoba-Fontelos model. Time permitting, we will also discuss the use of computer-assisted techniques to rigorously prove that our numerically found solutions are close to exact, true solutions. Joint work with Yongji Wang, Tristan Buckmaster, Javier Gomez-Serrano, Ching-Yao Lai, and the team from Google DeepMind.

Abstracts

Jean-Michel Morel Lingnan University

On Interpolation Formulas Describing Neural Network Generalization

In 2020, Pedro Domingos proposed an interpolation formula that is valid for any model learnt using deterministic gradient descent. This formula expresses the output of a trained machine at a test point as a weighted sum of contributions from all the training samples along the optimisation path. These weights are the scalar products of the machine's gradients with respect to its parameters, computed at the test and training data respectively. This result, which was proven for deterministic gradient descent, supports the idea that learning involves storing data-dependent information in an evolving tangent feature geometry. Predictions at test time then arise from the retrieval and aggregation of these stored features using a kernel weighting. Generalisation is governed by the alignment between the test points and the learned feature memory.We will demonstrate that Domingos's interpolation formula can be extended to batch-based stochastic optimisation. First-order interpolation formulas are obtained in terms of the learning rate, with a form that varies depending on the type of stochastic optimisation performed: gradient descent (GD), stochastic gradient descent (SGD), and stochastic gradient descent with momentum (SGDM). These formulas have a second-order counterpart that captures how local loss curvature and mini-batch fluctuations further refine the prediction under finite learning rates. We validate the theory through experiments, demonstrating that second-order representations provide a more accurate description of test output than the first-order approximation.

Maria Bruna University of Oxford

Microscopic interactions and macroscopic PDEs: beyond the mean-field paradigm

Many PDE models arising in collective behaviour, optimisation, and machine learning can be interpreted as limits of interacting particle systems. While mean-field limits are by now well understood and widely used, they capture only one regime of interaction. In this talk, I will present a broader perspective on particle-to-continuum limits, focusing on how different interaction scales lead to different classes of PDEs. Weak, long-range interactions give rise to nonlocal mean-field equations, whereas short-range or localised interactions lead to nonlinear diffusion-type equations. In contrast, strongly interacting systems, such as those with exclusion or finite-size effects, can exhibit macroscopic behaviour that deviates significantly from mean-field predictions, particularly in multi-species or non-gradient settings. Using examples from both lattice models and interacting diffusions, I will highlight the mechanisms behind these limits and discuss what carries over (and what breaks down) between regimes. This viewpoint suggests new challenges for connecting microscopic models with PDEs used in machine learning and related areas.

Abstracts

Harbir Antil **GMU, George Mason University**

Digital Twins and Beyond: A PDE-Constrained Optimization Perspective

Digital Twins (DTs) are adaptive, real-time virtual replicas of physical systems that integrate physics-based models, sensor data, and intelligent decision-making. At their core, DTs can be rigorously framed within PDE-constrained optimization (PDECO). This talk develops a unified PDECO framework for state estimation and control, leveraging adjoint-based methods in both deterministic and stochastic settings. To address the challenges of infinite-dimensional, large-scale optimization, we introduce novel function-space trust-region and augmented Lagrangian algorithms, and explore the role of randomized methods in dynamic PDECO. Applications span a wide range of domains, including structural and biomedical systems--from bridges and dams to aneurysm modeling, optimal insulation, electromagnetic cloaking, light bending, fusion, and neuromorphic computing. Together, these examples highlight a pathway toward predictive, adaptive, and trustworthy Digital Twins and AI technologies.

Ulrik Skre Fjordholm **University of Oslo**

The zero-noise limit for hyperbolic conservation laws

Over the past two decades, the phenomenon of regularization by noise has received an enormous amount of attention. Put simply, this is a general phenomenon in which a stochastic differential equation might exhibit better properties — e.g., existence or uniqueness of solutions, or increased regularity — compared to its deterministic counterpart. An early example is the seminal work of Flandoli, Gubinelli & Priola (Inventiones Mathematicae, 2010), where the authors prove that a specific stochastically perturbed transport equation is well-posed even for very irregular (Hölder-continuous) velocity fields. The purpose of this work is threefold. First, we design a novel stochastical perturbation of general scalar conservation laws, and prove that this SPDE is well-posed, without imposing any entropy conditions. Second, we show that there is sufficient compactness to pass the noise parameter to zero. Third, we use a novel stability property of scalar conservation laws to prove that the zero-noise limit is in fact the entropy solution of the deterministic problem. In this way, the addition of (a vanishing amount of) noise acts as a selection mechanism, which coincides with the standard entropy conditions. This is joint work with Ola Mæhlen (Université Paris-Saclay) and Magnus Ch. Ørke (University of Oslo).

Abstracts

Riccardo Adami PoliTO, Politecnico di Torino

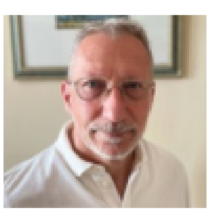
A mathematical model for the Einstein-Podolsky-Rosen phenomenon

At the core of the second technological quantum revolution is a physical phenomenon known as "entanglement". First figured out by Schrödinger, it was employed in a famous article by Einstein, Podolsky and Rosen to show the incompleteness of Quantum Mechanics. The interest on entanglement arose then again in the sixties, and since then it has been deeply investigated, both theoretically and experimentally. In this talk, we construct a mathematical model that describes the evolution of two entangled particles and a spin, that interacts with one of the two. As a result, we give a quantitative description of the phenomenon of the entanglement and, owing to a suitable scaling, we single out the regime in which the phenomenon occurs. This is a joint work with Luigi Barletti and Alessandro Teta.

Lorenzo Pareschi Heriot Watt University and Università degli studi di Ferrara

Structure-Preserving Neural Surrogates for Uncertainty Quantification in Plasma Physics

Reliable uncertainty quantification is a central challenge in plasma simulation, especially in kinetic regimes where predictive computations remain extremely expensive. This issue is particularly relevant in fusion-oriented plasma modeling, where multiscale effects, high dimensionality, and sensitivity to uncertain inputs make brute-force sampling unaffordable. In this talk I will present a multifidelity framework for the Vlasov-Poisson-Landau equation that combines asymptotic-preserving solvers, reduced plasma models, and tensor neural surrogates based on a micro-macro decomposition. The resulting approach produces inexpensive low-fidelity samples that remain strongly correlated with the high-fidelity kinetic model, leading to substantial variance reduction and computational savings. More broadly, this provides an example of how machine learning can become genuinely effective for PDEs when it is built around structure rather than used as a black box.



Francesco Maddalena Poliba, Politecnico di Bari

Multiple Scales in a Nonlocal Evolution Equation of Continuum Mechanics

The analysis of solutions of a linear peridynamic equation reveals some interesting features due to the particular non-homogeneous dispersion relation, which constitutes the main source of a nontrivial scale-dependent behaviour. The talk will focus on a quantitative analysis of these aspects, also in the perspective of their physical relevance.

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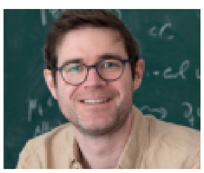
Abstracts

Antonio Alvarez **UAM, Autonomous University of Madrid and FAU, Friedrich-Alexander-Universität Erlangen-Nürnberg**

Perceptrons and localization of attention's mean-field landscape

Self-attention, the core mechanism behind modern Transformers, admits a natural mean-field description as a gradient flow on the sphere. In this talk, I will discuss what happens when attention is coupled with a perceptron term, leading to a simplified mean-field model for Transformer layers. The main message is that the perceptron induces a localization mechanism: under suitable structural assumptions, stationary measures are forced to be singular, and in dimension two they are in fact purely atomic with finite support. Thus, even in the descent regime, where attention alone favors diffuse equilibria, the perceptron can enforce clustered stationary states. I will also discuss anti-concentration estimates in the descent regime, showing that these discrete stable equilibria cannot concentrate too much mass inside a small cluster.



Emil Wiedemann **FAU, Friedrich-Alexander-Universität Erlangen-Nürnberg**

Beyond Incompatibility: Using Optimal Transport for Algorithmic Fairness

Automated decision-making has been proposed and used, for instance, in college admissions, credit scoring, and even criminal justice. It was originally hoped to yield fairer results by avoiding human biases, and thus to minimise effects of discrimination. Of course this turned out wrong ("bias in, bias out"), sparking serious concern in the public and media. Even worse, it turns out that different, equally plausible fairness criteria can be fundamentally incompatible with each other. Indeed, a strongly politicised debate about racial discrimination through the COMPAS algorithm in US criminal justice essentially boils down to such an incompatibility, as shown in a highly cited paper by Kleinberg et al. (2016). I will give a complete and very elementary proof of their incompatibility theorem, and discuss how such incompatibilities can be mitigated via optimal transport methods. Joint work with Meike Zehlike and Philipp Hacker.

Sam G. Krupa **ENS Paris, École Normale Supérieure – PSL**

Are L^∞ solutions to hyperbolic systems of conservation laws unique?

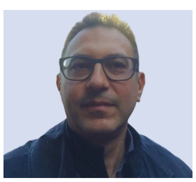
For hyperbolic systems of conservation laws in 1-D, fundamental questions about uniqueness and blow up of weak solutions still remain even for the apparently "simple" systems of two conserved quantities such as isentropic Euler and the p-system. Similarly, in the multi-dimensional case, a longstanding open question has been the uniqueness of weak solutions with initial data corresponding to the compressible vortex sheet. We address all of these questions by using the lens of convex integration, a general method of constructing highly irregular and non-unique solutions to PDEs. Our proofs involve computer-assistance. This talk is based on joint work with László Székelyhidi, Jr.

Abstracts

Yanzhi Wu **FAU DCN-AvH Friedrich-Alexander-Universität Erlangen-Nürnberg**

Data-Driven Control of Unknown Linear Systems: Two Disturbance Models

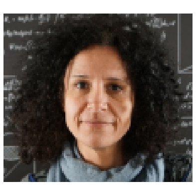
This talk discusses data-driven control of unknown linear systems under two disturbance models. For exosystem-generated disturbances, the framework is optimal output regulation: regulator equations characterize the required steady-state response, and adaptive dynamic programming learns the feedback component while feedforward regulation is obtained from the regulator equations. For stochastic disturbances with distributional ambiguity, the framework becomes mean-penalized Wasserstein distributionally robust control: a finite-horizon minimax Bellman recursion is learned from input-output data using a history-based state representation and quadratic Q-function parameterization. The talk highlights how the disturbance model determines the mathematical object, the learning algorithm, and the resulting regulation or robust-performance guarantee.



Luigi Berselli **Unipi, University of Pisa**

Womersley type flows for a non Newtonian fluid with variable exponent

We study the fully-developed, time-periodic motion of a shear-dependent non-Newtonian fluid with variable exponent rheology through an infinite pipe, with Dirichlet conditions. The main new results concern $p(\cdot)$-fluid models. We identify classes of exact solutions, relevant as benchmark cases, especially for electro-rheological fluids together with abstract existence results confirmed by numerical experiments.



Annalisa Cesaroni **Unipd, Università degli Studi di Padova**

Analysis of commuting times in a linear city

In this talk, I will provide a mathematical model (in a simplified framework) that describes the daily phenomenon in which each of thousand of citizens chooses to commute from a given location to another one, starting at a given time and somehow guessing the arrival time. In the discrete setting, I will use the celebrated Follow-the-Leader model, with the original feature of cars entering and exiting at different times, and I will provide the convergence as the number of players increase to infinity to a balance law in the continuous setting. Based on joint works (in progress) with F. Ancona, L. Caravenna, E. Marconi, A. Marson from University of Padova and with F. Rossi from IUAV Venice.

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