

Workshop. Machine Learning and PDEs

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Welcoming Speech by Enrique Zuazua

April 28, 2025

Dear colleagues and friends, friends and colleagues,

Welcome to FAU, on behalf of the Mathematics of Data - MoD Research Center.
Herzlich Willkommen!

Emmy Noether was born here and obtained her PhD degree in this very place. She famously said that the task of mathematicians is not to study objects, but rather the relations between objects. Her famous theorem on symmetries and invariances serves as a perfect example.

This captures the spirit of our workshop: building bridges between Machine Learning (ML) and Partial Differential Equations (PDEs). Both fields have much to learn from each other, and our goal over the next three days is to contribute to this dialogue by exploring the rich and growing network of connections between them.

Applied Mathematics is a remarkably versatile discipline, always eager to integrate new ideas and methods. Yet it remains committed to maintaining the high-fidelity criteria that any new methodology must meet. Innovation and rigor go hand in hand.

Later in her career, Noether worked alongside David Hilbert and Felix Klein in Göttingen, pursuing a systematic exploration of the interconnections across mathematical fields. Felix Klein also held a professorship here at FAU, where he formulated his renowned Erlangen Program.

Our university, deeply rooted in this mathematical tradition, benefits today from a vibrant network of cooperating institutions: the Fraunhofer and the Max Planck Institutes, companies like Siemens, Schaeffler, Adidas, and many others. They motivate and support us in developing a holistic strategy, pushing our mathematical endeavors toward fascinating real-world applications, particularly in areas like medical imaging.

Medical imaging is perhaps one of the most remarkable examples of the unexpected success of mathematics. In 1917, Johannes Radon, who was also a professor here, invented the Radon transform — from a purely mathematical perspective, inspired perhaps by Riemann, Fubini, and developments in analysis, PDE and geometry. He wondered whether a function could be reconstructed from its one-dimensional slices.

It took more than fifty years for his breakthrough ideas to revolutionize medicine through the invention of computed tomography (CT scans).

A similar story unfolded in the field of Machine Learning and AI. In 1932, Norbert Wiener published his seminal work on Tauberian theorems. Fifty-seven years later, George Cybenko's paper on the Universal Approximation Theorem opened the door to a new generation of ML algorithms.

Thus, we find ourselves at the perfect place — historically and intellectually — to celebrate the fertile interconnections between traditional computational and applied mathematics, and emerging fields like ML and AI.

The idea for this workshop grew out of discussions last year with our friends from the Politecnico di Bari, especially Professor Giuseppe Coclite and his group. Nicola de Nitti, who completed his Bachelor's degree in Bari, pursued his PhD here at FAU, and later continued as a researcher in Pisa, also played a key role in this initiative.

We hope that this collaboration will continue — and perhaps, who knows, there will be another edition of this workshop in the future!

We have been very fortunate in Erlangen. Thanks to the generous support of FAU, we were able to establish a Chair and the MoD Center. This would not have been possible without the outstanding backing of the Humboldt Foundation, and other German agencies like DAAD and DFG.

We have also received valuable funding from European agencies, including the ERC and the Marie Curie program. Companies such as Schaeffler and Sherpa AI (from Bilbao) have supported and inspired our work as well.

Finally, this workshop, and much of our research, owes a great deal to the European Office of the US AFOSR, represented here today by Captain Dr. Felix J. Knutson. Thank you, Felix, for being with us.

We also hope that Fariba Fahroo, our colleague, friend, and mathematician in charge of the program in Washington DC, will be able to join us online.

All of this has been made possible thanks to the dedication and professionalism of Lorenzo Liverani, also Italian, and now a valued member of our FAU family. Thank you, Lorenzo.

Thank you all for being here — and I wish you a stimulating and inspiring workshop!

