University of Basel
Department of Biomedical Engineering

Seminar Series:
**Latest Breakthroughs in Biomedical Engineering Research**

Location: DBE Science Lounge, Hegenheimermattweg 167C, 4123 Allschwil
Date & Time: Thursday 24.09.2026 | 16:30 – 17:30
Host: Prof. Philippe Cattin and Paul Friedrich

# Going Off-Grid: Neural Fields from Medical Imaging to Biomechanical Surrogates


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## Abstract

Medical image analysis and biomechanical modeling have traditionally relied on discrete, grid- or mesh-based representations. While effective, these discretized structures introduce fundamental trade-offs between resolution, memory overhead, and geometric flexibility. Neural fields, or implicit neural representations (INRs), offer a paradigm shift by parameterizing signals as continuous functions parameterized by deep neural networks. In this talk, I will explore how off-grid representations are transforming both medical imaging and patient-specific biomechanics. First, we will examine neural fields in medical imaging, demonstrating how coordinate-based networks enable arbitrary-resolution image representation and shape modeling without the constraints of traditional voxel grids. We will explore how continuous representations handle complex, dynamic anatomy in cardiovascular imaging and naturally adapt to irregular sampling and unstructured data. Building on these imaging foundations, I will bridge the gap to neural surrogate modeling and demonstrate how neural surrogates that map spatiotemporal coordinates or geometric parameters to physical fields (such as displacement, stress, or fluid dynamics) can be viewed as extended neural fields. By embedding physical priors and operator learning into continuous representations, we can bypass computationally heavy finite element simulations, enabling rapid, patient-specific biomechanical predictions. Finally, I will reflect on how linking continuous vision with continuous mechanics creates a unified pipeline for digital twins in cardiovascular care, enabling seamless transitions from high-fidelity imaging to instantaneous biomechanical feedback.


## Biosketch

Dr. Jelmer Wolterink is an associate professor in the Department of Applied Mathematics and Technical Medical Center at the University of Twente (Enschede, The Netherlands). His research interests focus on the development of deep learning methods for diagnosis, prognosis and treatment planning in cardiovascular imaging, including shape analysis, surrogate modeling for biomechanical problems, and integration of multimodal clinical data. He has published over 100 peer-reviewed articles on these topics, collaborates extensively with clinical partners in radiology, vascular surgery, and cardiology, and serves as associate editor of Neurocomputing, IEEE TMI, Medical Image Analysis.