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SEMINAR

Fast Physics-Informed Machine Learning for High-Rate Structural Health Monitoring

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Timetable:

October 12th 2023 - 11:00 a.m. (CET)

Location:

UNIPG Campus of Engineering
Via G. Duranti, 93, Perugia
Aula Magna

[Link to the seminar](#)

Abstract

Advances in science and engineering are empowering high-rate dynamic systems, such as hypersonic vehicles, advanced weaponries, and active shock and blast mitigation strategies. The real-time estimation of structural health of high-rate systems, termed high-rate structural health monitoring (HRSHM), is critical in designing decision mechanisms that can ensure structural integrity and performance. However, this is a difficult task, because these systems are uniquely characterized by 1) large uncertainties in the external loads; 2) high levels of non-stationarities and heavy disturbances; and 3) unmodeled dynamics generated from changes in system configurations. In addition, because these systems are experiencing events of high amplitudes (beyond 100 g) over short durations (under 100 ms), a successful feedback mechanism is one that can operate under 1 ms. A solution to the unique system characteristics and temporal constraint is the design and application of real-time learning algorithms. In this talk, we review and discuss real-time learning algorithms for HRSHM applications. In particular, after introducing the HRSHM challenge, we explore fast real-time learning of time-series prediction using conventional and deep neural networks, and demonstrate a path to real-time state estimation through physics-informed machine learning. Specifically, we are interested in tools inspired from algebraic topology, including the embedding theorem and topological data analysis. We show that topological data analysis holds important promise in a physics-informed machine learning environment.



Simon Laflamme is the Waldo. W. Wegner Professor in Civil Engineering in the Department of Civil, Construction, and Environmental Engineering at Iowa State University, and holds a Courtesy Appointment in the Department of Electrical and Computer Engineering. He received his Ph.D in Structures and Materials from the Massachusetts Institute of Technology in 2011, and was granted the Early Achievement in Research Award (2017) and the Mid-Career Achievement in Research Award (2022) by Iowa State University. Dr. Laflamme has amassed more than 10 million USD in research projects from various sources, including NSF, DOD, and USDOT. He is a member of various editorial boards including Mechanical Systems and Signal Processing, Measurement Science and Technology, and Sensors. His research yielded a textbook on Structural Motion Engineering, five U.S. patents, and more than 250 articles in the areas of Smart Structures and Systems, Structural Control, and Structural Health Monitoring

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