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MACHINE LEARNING FOR ENGINEERING PROBLEMS: AN INTRODUCTION TO CONVOLUTIONAL NEURAL NETWORK

Prof. Giuseppe Quaranta
Department of Structural and Geotechnical Engineering, Sapienza University of Rome, Italy

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Department of Engineering - Room 205

Live Streaming Teams at the following link:
https://bit.ly/3LTRUte

This talk introduces some neural network architectures that leverage convolution operations. We begin by reviewing one-dimensional (1D) convolutions in the context of machine learning and discussing essential implementation aspects, including padding, stride, kernel size, dilation, activation functions, and pooling. Two key architectures — autoencoders and generative adversarial networks — are then examined, both employing 1D convolutional layers. Building on this foundation, we explore the potential of these architectures for damage detection in nonlinear dynamic systems subjected to uncertain dynamic loads. This problem remains largely unexplored and presents notable challenges, as nonlinear systems can exhibit highly variable responses under random vibrations with changing excitation levels. Consequently, distinguishing damage-induced effects from those arising from inherent nonlinear behavior is particularly complex. The proposed approach enables damage detection under random vibrations of varying intensity, without prior knowledge of the system or excitation, and in a fully unsupervised manner. Numerical and experimental studies are presented to demonstrate both the capabilities and limitations of convolutional neural network architectures for damage detection in nonlinear dynamic systems.

Giuseppe Quaranta is an Associate Professor of Structural Engineering in the Department of Structural and Geotechnical Engineering at Sapienza University of Rome, Italy. Since 2020, he has also held the National Habilitation for Full Professor in Structural Engineering. He earned his M.Sc. in Civil Engineering from the Technical University of Bari, Italy, in 2006, and his Ph.D. in Structural Engineering from Sapienza University of Rome in 2011. Prior to joining Sapienza University of Rome, he was a Postdoctoral Scholar at the University of California, Davis, USA. Giuseppe Quaranta's research focuses on structural monitoring and control – encompassing the design of sensing systems, development of dynamic identification and diagnostic techniques, and the application of passive vibration control devices – as well as on structural concrete, including reinforced concrete and composite steel-concrete structures. His research activities draw on a combination of experimental testing, analytical methods, and computational approaches, including advanced machine learning techniques.