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Case Western Reserve University
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Civil and Environmental Engineering Department Seminar

Prediction of Seismic Responses of Nonlinear Structural Systems Using Deep-Learning

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February 25, 2021, 12:45 – 2:00 PM

Join Zoom Meeting
URL: https://cwru.zoom.us/j/92502635986?pwd=dkZEMWVocGZWL0UvQlJudlM4bHl5Zz09
Meeting ID: 925 0263 5986 Passcode: 151477

Abstract
Structural failures caused by a strong earthquake may induce a large number of casualties and substantial socioeconomic losses. To design a structure that can withstand such earthquake events, it is essential to accurately estimate the nonlinear structural responses caused by strong ground motions. Simple regression-based equations have been widely adopted in routine engineering practices to replace an onerous and complicated nonlinear time history analysis. However, it is noted that the response prediction is deterministic, which cannot quantify the variabilities stemming from the nonlinear behaviour of the structural system. Also, it is well known that the accuracy of prediction based on the regression-based equations is limited. To quantify uncertainties and improve the prediction accuracy, a probabilistic deep neural network (DNN) model based on a Bayesian deep learning method is proposed in this research. The DNN model is trained with a large number of nonlinear SDOF responses. By introducing a loss function proportional to the negative log-likelihood of the Gaussian distribution function, the mean and variance of the structural responses can be obtained. This assessment is essential for earthquake engineering applications because of the large randomness in the input ground motion details and their significant impact on the structural responses. Using the proposed probabilistic deep neural network model, one can efficiently estimate the seismic response of nonlinear structural systems.

Bio sketch

Professor Kwon earned his Ph.D. degree from the University of Illinois at Urbana-Champaign in 2007. He was appointed as an Assistant Professor at the Missouri University of Science and Technology in 2008. He moved to the University of Toronto in 2010, was promoted to an Associate Professor and Professor in 2015 and 2020, respectively. His research group focuses on developing advanced simulation methods, including hybrid (experimental-numerical) simulation, seismic response prediction with DNN, and assessment of nuclear power plants subjected to various loading conditions. He has published over 70 journal papers. He is currently serving as an associate editor of the ASCE Journal of Structural Engineering and served as a chair of the ASCE Performance Based Design for Structures Committee.