Machine learning aided structural uncertainty and reliability analysis

†*Wei Gao, Qihan Wang, Yuan Feng, Qingya Li, Di Wu

Centre for Infrastructure Engineering and Safety (CIES),
School of Civil and Environmental Engineering, The University of New South Wales, Sydney, NSW 2052, Australia

*Presenting author: w.gao@unsw.edu.au
†Corresponding author: w.gao@unsw.edu.au

Abstract

In engineering applications, the system responses can be significantly affected by uncertainties in its material and geometric properties as well as excitations. To improve the computational efficiency, metamodels are widely used to surrogate the relationship between the system inputs and outputs. In this study, a new machine learning based metamodel, namely the extended support vector regression (X-SVR), is proposed for the structural response analysis and reliability assessment. The capability of X-SVR is further enhanced by a new kernel function developed from the vectorized Gegenbauer polynomial, especially for solving complex engineering problems. Through the proposed approach, the relationship between the structural responses and the input uncertain parameters is approximated by training the X-SVR model such that the probability of failure can be efficiently predicted without using other computational tools for numerical analysis. The feasibility and performance of the proposed machine learning aided structural analysis and reliability assessment is investigated through comparisons with some benchmark methods. Numerical examples are also employed to evidently demonstrate the practicability and efficiency of the proposed machine learning aided data-driven framework for structural uncertainty and reliability analysis.

Keywords: Machine learning; Data-driven; Extended support vector regression (X-SVR); Uncertainty analysis; Reliability.